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Doctoral Thesis

Title:

Perceptions Of Teachers on Integrating IBPYP and STEAM in IBPYP schools in Riyadh

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Thesis

Abstract

The purpose of this study is to investigate the possibility of implementing STEAM education in the Riyadh schools that is already implemented in the IB PYP program. This research also points out a theoretical synergy between STEAM's interdisciplinary, project-based engagement and IB PYP's transdisciplinary design. However, the problem of a lack of resources, inadequate professional development, and numerous barriers at the institutional level poses challenges to the integration process. The positive influence of STEAM was identified in the aspect of students' engagement and creativity, while the measurement of interdisciplinary and creative learning remained challenging within the framework of IB PYP. The strategies proposed are focused on increasing professional development of teachers, resource equity via support for technology, and pre-service and in-service collaboration among educators. Mitigating these challenges will improve STEAM integration and the quality of education and fully align with the nation's Vision 2030.

Keywords*: STEAM education, IB PYP, interdisciplinary learning, student engagement, professional development, Riyadh schools, creativity, inquiry-based learning.*

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Chapter 1: Introduction

1.1 Background

In contemporary society, many educational systems have embraced STEM to enhance the development of cognitive and analytical skills among learners (Felder & Brent, 2024). The next development of this model termed STEAM, adds Arts to make it a creative approach to learning STEM subjects. This approach is consistent with the current understanding of the need for students to learn in an interdisciplinary manner to meet the demands of the future. Therefore, STEAM education aims to equip students with the ability to reason, think logically, and solve problems proactively in various areas of society (Shatunova et al., 2019). The concept-based, planning, and inquiry approach to learning embraced by the International Baccalaureate Primary Years Program (IB PYP) aids learners in identifying relationships between subjects in which they are interested (Sareen, 2024). Therefore, the IB PYP, with its integration of TIB and emphasis on the teaching process as an inquiry, encourages students to continue learning throughout their lives by focusing on real-world problems. Therefore, the compatibility of STEAM and IB PYP in terms of pedagogy demonstrates a proper understanding of their integration in the sphere of educational advancement (Medwell et al., 2020).

However, in recent years, Riyadh city in Saudi Arabia has witnessed some inclinations towards adoption of such international educational models as the IB PYP (Aljabreen, 2020). The concern stems from the new and shifting approaches to employee recruitment, coupled with the Kingdom's Vision 2030 regarding education, which has prompted schools to explore ways to enhance student curriculums to align with the future market of science and technology (Thaha Abdullateef et al., 2023). However, the deep exploration of the application of STEAM in the context of IB PYP implementation in Riyadh remains unexplored. This study aims to identify the following questions; how Riyadh schools are integrating STEAM in the IB PYP, challenges that accompany it, and the effects on students' learning and motivation towards education development in the region.

1.2 Problem Statement

The process of enhancing and evolving education systems for a more technologically inclined society has seen the integration of STEM or STEAM curriculum in many schools all over the world (Ammar et al., 2024). However, there is a challenge in the incorporation of STEM and STEAM in the International Baccalaureate Primary Years Programme (IB PYP) curriculum. The IB PYP fosters inquiry, transdisciplinary approaches to learning, critical thinking skills, as well as problem-solving skills and creativity in compliances with STEAM (Šmitienė & Kesylė, 2022). However, schools in Riyadh are not well informed regarding the application of these frameworks in addition to their effectiveness.

In Riyadh, where the IB PYP curriculum adoption is still new and limited more so affecting only the private schools, the integration of STEAM learning could lead to more enriched and enhanced experiential learning, through using the inter-disciplinary thinking and creativity. However, teachers and administrators find it difficult to find time to teach STEAM and find ways of integrating it into the school's instructional programme under the IB PYP regime. It also adds other difficulties such as readiness of teachers, availability of resources, and fit of ideas of current forms of evaluation and practices. Moreover, there are cultural and educational issues regarding the western models in KSA schools such as IB PYP and STEAM curriculum in Riyadh (Khair, 2024).

For this reason, this research seeks to establish the level of implementation of the STEAM model in IB PYP schools in Riyadh. To these objectives, the study shall examine the challenges that teachers encounter, possible interventions of these difficulties, and the effects of these interventions on the student's attitudes and accomplishments. The goal of the research is to formulate a model that schools will embrace in implementing these learning paradigms in Saudi Arabia for interdisciplinary and inquiry-based learning.

1.3 Research Aim and Objectives

The aim of this research is to explore the integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) into the International Baccalaureate Primary Years Programme (IB PYP) in Riyadh schools.

- To analyse the theoretical and practical alignment between STEAM and the IB PYP frameworks.
- To examine the difficulties experienced by Riyadh schools in implementing STEAM in the context of IB PYP.
- To evaluate the impact of STEAM integration on student engagement, creativity, and learning outcomes in IB PYP schools.
- To propose strategies for effectively integrating STEAM into the IB PYP framework in Riyadh schools.

1.4 Research Questions

- How does the integration of STEAM align with the transdisciplinary and inquiry-based principles of the IB PYP?
- What challenges do educators and schools in Riyadh face when attempting to integrate STEAM into the IB PYP curriculum?
- What impact does STEAM integration have on student engagement, creativity, and learning outcomes in IB PYP schools in Riyadh?
- What strategies can be developed to overcome challenges and successfully integrate STEAM into IB PYP schools in Riyadh?

1.5 Research Significance

This study has implications for educators, school leaders, and policy makers especially in Riyadh given the emerging trends in education such as STEAM and IB PYP. Therefore, it can be useful for the further investigation of the possible synergies between STEAM and IB PYP to support interdisciplinary and inquiry-based learning with the help of creativity and technology (Gürkan, 2021). The implication will offer a way of addressing some of the challenges that are evident in most Saudi schools such as resource constraints, teacher preparedness, and curriculum integration.

Furthermore, the study contributes to the literature by focusing on STEAM-IB PYP integration in a non-Western and presenting culturally appropriate strategies that can be implemented in Riyadh schools. The research will also help students to develop critical thinking, creativity, and problem-solving skills, which are valuable assets as they face challenges in the technological

society. In addition, it helps in promoting the global education standards by ensuring that the local education systems conform to the international standards.

1.6 Structure of the Thesis

This thesis is organised into six chapters, each addressing a specific aspect of the research study on integrating STEAM into the IB PYP framework in Riyadh schools.

Table 1 Structure of the Thesis

Chapter	Title	Description
Chapter 1	Introduction	Provides an overview of the research context, the rationale for the study, research objectives, and key research questions.
Chapter 2	Literature Review	Reviews existing literature on STEAM education, the IB PYP framework, and related studies to establish a theoretical foundation for the research.
Chapter 3	Research Methodology	Outlines the research design, philosophy, approach, and methods used in data collection and analysis, including ethical considerations.
Chapter 4	Data Analysis and Findings	Presents the results of quantitative and qualitative data analysis, highlighting key findings related to STEAM integration in the IB PYP setting.
Chapter 5	Discussion	Interprets the findings in relation to existing literature, discusses implications, and addresses the research questions and hypotheses.
Chapter 6	Recommendations and Conclusion	Summarises the study's findings, provides recommendations for STEAM implementation in IB PYP, and discusses limitations and areas for future research.

Chapter 2: Literature Review

2.1 Introduction

The integration and implementation of STEM and STEAM with the arts in the International Baccalaureate Primary Years Program (IB PYP) in Riyadh schools has grown significantly (Dubie, 2024). STEM and STEAM include problem solving, innovation and integration of the subject areas, which are aligned to inquiry and central to the notion of IB PYP. The purpose of this combination is to enhance the skills, which are deemed relevant in the society today such as critical thinking skills, innovative skills and speaking skills. In Saudi Arabian education, integrating these frameworks is in line with the general goal of Vision 2030 of adopting technology and nurturing students towards a knowledge-based society (Mohamed et al., 2021). This literature review highlighted past research on STEM and STEAM, the connection between the two and IB PYP, alongside the opportunities and challenges that could accompany the implementation of the models in Riyadh schools. Some of the key themes that emerged include readiness for teaching, access to resources, curriculum incorporation, and an analysis of STEM and STEAM education both nationally and globally.

2.2 Theoretical Foundations of STEM and STEAM Education

2.2.1 Definition of STEM and STEAM

STEM, which stands for Science, Technology, Engineering, and Math, was created in the early twentieth century to address the issue of employment in STEM fields (McCauley-Lerrigan, 2022). This shift to STEAM which has Arts as one of its subjects acknowledges education not only as a delivery of specific competencies and information but also as a cultivation of innovation (Honey and Kanter, 2013). The incorporation of Arts in the curriculum is crucial in the development of the students' creative thinking and problem-solving skills. The integration of artistic elements in STEAM education is considered to positively influence students' interest and motivation, improving their learning experience (Quigley, Herro, & Jamil, 2017).

According to Colucci-Gray et al., (2019), STEAM promotes integration of learning and the students' all-round growth and development. In addition, Parker and Thomsen (2019) note that playful, integrated pedagogies in STEAM learning environments develop key competencies that are essential for children's development enabling them to navigate through real-life situations.

Therefore, including Arts in STEM is not simply adding one more field of study but is a shift that is significant to the enhancement of both teaching and learning processes.

2.2.2 Overview of the IB Primary Years Programme (PYP)

The International Baccalaureate Primary Years Programme (IB PYP) is currently an all- inclusive, inquiry-based curriculum meant for students ranging from 3 to 12 years of age and widely focuses on the promotion of critical thinking, interdisciplinary thinking, and international mindedness among students. This paradigm promotes students' learning and development as they connect various subjects and issues, both academically and personally. As per Gürkan (2021), the PYP emphasises integration of knowledge across subject areas, so students are able to develop a more profound understanding of the relationships that exist in various fields of learning. The IB PYP emphasises learner-centered activities involving exploration and inquiry, suggesting that the program would be effective in integration with concepts like STEAM.

The IB PYP enhances students' higher-order thinking skills that they feel are necessary in solving problems in their world. A study by Tarigan et al., (2019), discussed that when emphasising on critical thinking it assists the students most especially in area of mathematics where creativity is limited because of the procedures that are followed. Furthermore, Rabaah et al (2016), analysed that early childhood education and the PYP are consistent in Saudi Arabia specifically in relation to the principle of inquiry and culture that is imperative for developing an international mind. Although, the integration of the concept of the IB PYP is effective for the school in its implementation. However, it requires trained teachers and materials in the regions that are not that familiar with the International Baccalaureate programs.

2.2.3 Integration of IB PYP Elements with STEAM

The IB PYP unites element like themes, approaches to learning (ATLs), the learner profile attributes and student action to promote inquiry by the students and ensure holistic development (Wootten, 2019; Lesrer & Lochmiller 2015). Through STEAM, these elements build on each other to add depth and complexity to students learning engagement, increasing emphasis on the application of thinking skills, problem solving and connections drawn between science and other disciplines. The six transdisciplinary themes of the IB PYP involve students in the acquisition of knowledge across different disciplines while making connections to context. The integration of STEAM projects into these contexts enhances students' learning experiences and conceptions, aligning with the emphasis

on sustainability and science practices (Aoun, 2020). For example, work that is based on the discussion of "Sharing the Planet" can encompass specific Environmental Science and Engineering initiatives, which will enable the use of scientific and technological approaches.

The ATLs of IB PYP include thinking, communication and self-breaker skills all of which are crucial for learning in the STEAM. These skills may be best acquired through inquiry-based projects that are aligned with the specific content areas improving the general problem-solving and collaborative skills in context (Macharia, 2022). This integration develops the accomplishment of 21st-century competencies and hones the students for such challenges.

The IB learner profile attributes support attributes such as being an inquirer, a thinker, and a risk taker. The inquiry-based and action-oriented nature of practices continues to develop these attributes by exposing students to tasks that address real-world problems (Gürkan, 2021; Green, 2017). It also develops student self-regulation, critical thinking when problem solving enabled students to engage in meaningful knowledge application supporting the IB PYP aim of producing lifelong learners.

2.2.4 Challenges and Opportunities for IB PYP Alignment

Integrating context appropriate scientific understandings into the learning and teaching process in tune with IB YP has its advantages and limitations. Incorporating of teaching that is based on conceptual understanding with a mixture of cross-cutting concepts as well as scientific practice is compatible with learning model of IB PYP (Friend, 2022; Weiss-Dembek, 2024). However, there are factors that arise because of this difference in assessment practice. In contrast to concrete measures inherit to traditional science standards, the assessment of IB PYP are more flexible and linked to the inquiry and transdisciplinary themes of the programme. To overcome such hurdles, curriculum changes, faculty development, and planning with other stakeholders will require to be made (Dix & Sniedze, 2020).

2.2.5 Benefits of Integrating STEAM in Primary Schools (PYP Context)

The integration of STEAM in the Primary Learning within the context of IB PYP has the following benefits that are true to the program of inquiry and transdisciplinary nature (Macharia, 2022). However, the realisation of these benefits may be impacted by factors that hinder its implementation. Furthermore, STEAM subjects adopt the development of critical thinking by teaching students to connect knowledge from different subject areas, a strategy that aligns with the IB PYP. According to Blackley & Howell (2019), STEM integration in the context of solving real- life problems enhances analytical thinking and creativity among students stunningly. However, some schools may not have adequate support for such an implementation, and this can hamper full student engagement in this kind of learning.

Furthermore, the inclusion of creativity and innovation via the arts in STEAM enhances the learning process and accessibility. According to research by Honey & Kanter (2013), arranging art together with science and mathematics enhances imagination, teamwork, and enthusiasm among learners. The IB PYP program's intent includes concepts such as music, drawing, or drama to enhance technical knowledge, which makes elaboration meaningful for students. While arts have the potential to enhance STEM knowledge, limited resource availability may curtail such practices in some schools. However, STEAM's implementation of 'skills', which combines technical skills with creativity and aligns well with the IB PYP's learner profile, may be its greatest strength. According to Shatunova et al. (2019), authentically designed STEAM projects enable students to enhance their cognitive, social, and emotional skills, which are essential for effective cooperation. Though preparing teachers to integrate STEAM that aims at achieving the following goals can at times be challenging. Therefore, both STEAM and the IB PYP encourage the practical application of what the children learn. Through the practical and purposeful activities promoted in student projects, STEAM aligns with the IB PYP's goal of promoting international-mindedness. As Khair (2024) notes, this task is particularly pertinent for Saudi Arabia's Vision 2030 as it aims to build an efficient and effective workforce for tackling modern problems. While this is an important goal, meeting it demands significant curriculum changes and professional development. Although, the concept of implementing STEAM within the framework of the IB PYP has a strong potential for fostering critical, creative, and practical thinking, it is important to provide enough resources and prepare teachers for the specified approach (Gürkan, 2021).

2.2.6 Global Movements in STEM and STEAM

Over the last few years, there was a considerable effort on the part of nations on including STEM and STEAM education as significant components of national education for the future. As highlighted by the National Science and Technology Council (2013), the only way to promote science, technology, engineering, and mathematics is through embracing creativity and innovation to enhance the economic growth and competitiveness of the country. Governments globally are introducing policies to enhance STEM learning that is associated with an integration of subjects, problem-based approaches and teamwork (Nguyen et al., 2020). This shift follows the understanding that the students are encouraged to follow content from different disciplines, which in turn improves the students' reception of content and materials.

In addition, PricewaterhouseCoopers (2016), suggested that there is an increasing necessity to meet the requirements of the skills for the twenty-first century, including problem-solving skills, innovation, and interpersonal skills, which are critical to the current competitive job market. Through the growth of technological significance in industries, educators have been pushing towards preparing students for science and technological positions in related sectors (Borah et al., 2019). This trend is observed in different countries where the governments adopt measures that endorse the use of experience-based learning, use of projects as means of evaluation, and enhanced collaboration with the professionals in the field.

For example, the incorporation of Arts into Science, Technology, Engineering, and Mathematics now referred to as STEAM not only improves creativity, but it also encourages the students to work together (Belbase et al., 2021). It also makes certain that students are capable of thinking out of the box, come up with creative solutions while being proficient in various technologies that they may encounter in their future professions as proposed by (Ammar et al., 2024). It is necessary to admit that the adaptation of the national educational frameworks is one of the ways when the focus on STEM and STEAM education will be requirements of the knowledge- based economy.

2.3 IB PYP and Inquiry-Based Learning

2.3.1 Overview of IB PYP Framework

The inquiry-based transdisciplinary framework called International Baccalaureate Primary Years Programme (IB PYP) is implemented in schools for learners in the age range of 3-12 years (Bahn, 2022). The development of education aims to promote the all-round development of learners through a coherent approach towards learning and teaching procedures. This framework focuses on meaningful content knowledge, problem-solving, and cross-national learning, allowing students to blur the lines between different topics and see their application in the world. Many scholars investigated this approach from the perspective of advantages and disadvantages (Gürkan, 2020; Keay et al., 2018).

Research by Gürkan (2020), shows that designing a transdisciplinary, inquiry-based curriculum impacted the pre-service teachers in a positive way as they reduce rigidity and increase their interest towards educational learning. Subject co-teaching also benefits teachers as it expands their understanding of teaching techniques and challenges students can present in the classroom (Keay et al., 2018). However, the study also reveals that through inadequate training the teacher may have a challenge in implementing the framework by the confusion of the various disciplines.

Moreover, Sareen (2024), explores how sustainability education is incorporated within the IB PYP curriculum in Norway, connected to the Sustainable Development Goals. This proves that the implementation of IB PYP cultivates this understanding of global issues and empowers learners to positively affect the wellbeing of society. It is especially commendable in this aspect of the framework because it favours student learning in both terms of academic content and moral standing. However, a criticism of the framework is that sustainability themes may not be adequately developed unless teachers are familiar with the SDGs.

A study by Bassachs et al. (2020), evaluating the effectiveness of the IB PYP's learning through inquiry, illustrates how the process enhances students' critical reflection, especially through STEAM lessons. While helping the students develop critical thinking skills, it leaves the concern that without proper guidance, the content might only be mastered at the surface level with little focus on depth in their respective subjects. The type of inquiry that is facilitated by the IB PYP

framework, transdisciplinarity, is normatively useful in enhancing the learning opportunities and development of the students. However, one more important aspect that needs to be developed in more detail is the interaction of the teacher and the extent of integration of subjects.

2.3.2 Importance of Inquiry-Based Learning

Inquiry is part of current learning models including the International Baccalaureate Primary Years Programme (IB PYP), and has been further underscored in STEM (Science, Technology, Engineering, and Mathematics), and STEAM (Science, Technology, Engineering, Arts, and Mathematics). These approaches engage students in an activity and learning process whereby they are encouraged to inquire, search and solve disputes. STEM and STEAM foster integration with the IB PYP which is a constructivism based on inquiry and cultivates thinking and creativity (Herro et al., 2018).

In addition, Herro, Quigley & Cian, (2018), revealed the incorporation of inquiry-based learning and STEM/STEAM into critical thinking and innovation. This makes the students to be more active in their learning since they are part of the process of how the learning process takes place for aspects concerning STEAM learning where creativity is of essence. Furthermore, Bassachs et al., (2020) noted that through engagement in inquiry in STEAM, the student is able to be involved in such processes that enhance the manner in which the knowledge is transferred among the subjects. Such an approach aligns well with IB PYP's structure by teaching students how to interact with issues in a more hands-on fashion exercising the knowledge they obtain through practical application. On the other hand, other critics opine that without proper support from the teachers, student learning may reduce to mere participation in activities (Bassachs et al., 2020).

A study by Wells (2019), examines the use of inquiry based pedagogy in IB PYP to develop student agency, curiosity and collaboration. Through such inquiries, the student owns the learning process and drives the process of expanding or enhancing their learning skills. This concurs with the STEPSTONES framework for promoting independence of adolescents (Bratt et al., 2023). Learning is also carried out through asking questions as the students get to ask questions and find out answers for themselves, which enhances understanding and memory as suggested by Sareen (2024). The last advantage of inquiry is related to cooperation since learning in groups is common during lessons and helps in the growth of the efficiency of the learning process, as well as the

students' social and communication skills (Gürkan, 2020). However, the critics of the inquiry- based learning model have pointed out some of the underlying difficulties. Open tasks can be a problem for students as the absence of structure might make it difficult for them to overfocus and have an incomplete understanding of the topic. A research by Hood (2013), highlighted that teachers have a great role to play into such tasks especially in the manner to support their students to engage with content knowledge. Furthermore, learning by inquiry is also time-consuming; in its implementation, a significant amount of time and resources must be spent for optimal results (Gürkan, 2020). There is a special emphasis on inquiry-based learning with the help of STEM and STEAM in the context of the IB PYP framework as well as the opportunities that it offers for the students' agency, curiosity, and collaboration. It is evident that these methods provide immense benefits but they are only as good as the teacher time spent on a lesson and the preparation time given to a lesson and the resources dedicated to making the lesson engaging and effective.

2.4 Benefits of Merging STEM/STEAM with IB PYP in Riyadh Schools

2.4.1 Enhanced Learning Outcomes

The incorporation of STEAM into inquiry-based curricula, including the IB PYP, contributes to improved learning achievements due to transferable skills like problem-solving, creativity, and critical thinking. In this study, Erol et al. (2022), found that STEAM integrated with storytelling enhances problem-solving and creative thinking skills due to its integration of subjects. Rahmawati et al. (2019), pays more attention to STEAM approach in learning chemistry that enables critical and creative thinking process where students have to apply their knowledge. Furthermore, the National Science and Technology Council (2013), elaborates on STEM as an essential component for learning that fosters the concepts of innovation and problem-solving skills crucial for addressing problems of today and tomorrow.

The STEAM concept is a perfect match for the learning approach of the IB PYP as it incorporates the inquiry cycle where students pose questions, investigate, and engage in purposeful discussions which enhance understanding and retention (International Baccalaureate, n.d.). Language learning in the PYP also supports inquiry by nurturing such skills that are crucial in joint undertakings, especially in interdisciplinary areas like STEAM (International Baccalaureate, n.d.). The use of technology in language learning also supports this process, allowing students to work more effectively with technologies (Mansouri & Al-Hamadi, 2018). Last, The National Science

Teachers Association (2018) explain how English learners in STEM subject find inquire based approaches enhancing classroom and learning for all. STEAM in the IB PYP aims for trying to improve not only the academic success, but also to promote practical scenarios and skills that may be useful in a society that is turning into something new every day.

2.4.2 Inclusivity and Accessibility

STEAM (Science, Technology, Engineering, Arts, and Mathematics) education can be very effective in inclusion because it caters for the learners' multiple intelligences and this is very important in multicultural schools like Riyadh schools. As stated by the National Science Teachers Association (2018), STEAM learning engages the learners through tasks, thereby facilitating learning to students with diverse learning abilities and diverse cultural practices. Education developed an art integrated model of learning where, all subjects are covered and students are able to grasp knowledge in various forms; visual, through touching, and through hearing. This variety ensures that students with learning difficulties and those who are considered gifted, can be in a position to engage in the learning process.

As pointed out by Alsahrani (2012), schools in Riyadh are beginning to incorporate differentiation to enhance the learning of the students, given the diversified student populace. Differentiation in STEAM classrooms means creating task modifications, content adaptations, and assessment variations based on students' readiness, interest, and learning profile. Through multiple ways of learning, teachers can be guaranteed all students have a chance to succeed regardless of their background or learning capacity. It not only promotes the sense of equality among students but also helps them to use their critical thinking and problem solving skills in a way that is comfortable to them.

2.5 Challenges of Integrating STEAM into IB PYP

2.5.1 Teacher Preparedness and Professional Development

An understanding of the professional background of the teachers is paramount to achieving successful outcomes of STEM, and STEAM education in the context of Saudi Arabia. The issues in this area particularly in relation to Saudi higher learning institutions have been discussed elsewhere. In addition, Bin Othayman et al. (2022) highlight the absence of adequate training needs

analysis as a key challenge that hinders professional development programs. They claim that when trainers are unable to identify the exact needs of teachers, their training programs only offer broad solutions that fail to enhance the teaching success rates. This is particularly relevant in STEM/STEAM lessons, where subject integration and technological incorporation are critical.

Further, Al Mulhim (2014), described the challenges facing the integration of ICTs on the teaching process and observed that lack technical knowledge among teachers and poor technological resources are critical issues. Technology is integrated into STEM / STEAM education, and unless teachers receive preparation in ICT, it might be challenging to provide students with knowledge properly. The lack of readiness in approaching integration can limit the implementation of technologies in teaching processes, including project and simulation which are useful in enhancing critical thinking and problem-solving skills.

Moreover, Gryson et al. (2024), suggested CPD models like the Teacher Design Team (TDT) where teachers gain cross-cutting competencies and establish long-term professional development. By implementing TDTs, teachers can participate in the design of instructional resources together to promote teamwork and professional development. However, according to Alswilem (2019), teachers in Saudi Arabia are likely to experience challenges including limited resource and support, which cultivates the longevity of such measures. It is in tackling these barriers using specific professional development initiatives that the progress of STEM/ STEAM education in the country can be enhanced.

2.5.2 Curriculum, Assessment Alignment, and Resource Allocation

The implementation of STEAM principles within the context of the Saudi Arabia's International Baccalaureate Primary Years Programme (IB PYP) poses questions on curriculum correspondence and resource management. Among these challenges, one of the most important ones refers to the integration of STEAM's transdisciplinary nature with the assessment-oriented IB PYP. With a systematic design and positive emphasis on achievements, IB PYP's assessments are inopportune for STEAM learning, which is driven by curiosity-based investigations. Using standards to evaluate creativity and inquiry, which are fundamental to STEAM, can hinder the development of flexible approaches to learning and teaching across the disciplines (Almogbel,

2015). This is disadvantageous when measuring the learning experiences that STEAM intends to foster such as critical thinking and innovations.

However, other challenges such as technological support and resources are also areas in which schools in Saudi Arabia will have to work hard to improve and meet the requirements set by the curriculum. Mansouri and Al-Hamadi (2018), observed that schools fail to provide adequate technological support to support the implementation of STEAM activities such as robotics and coding. Therefore, such projects need proper tools and equipment that are often not easily accessible in less endowed schools. STEM Revolution (2018), also highlights the fact that technology is present in class, the trainers lack the necessary training to use it in teaching. This lack of technological resources and teacher preparedness hinders the potential of STEAM for learning environments in Saudi Arabia. Therefore, for STEAM to succeed in Saudi Arabia, a two- pronged approach is needed: altering the criteria for course and program evaluation to capture interdisciplinarity and creativity, as well as guaranteeing sufficient funding and the provision of appropriate technology for imaginative and practical assignments.

2.6 Strategies for Effective STEAM-IB PYP Integration

2.6.1 Professional Development for Teachers

The implementation of STEAM education in the International Baccalaureate Primary Years Programme (IB PYP) is directly linked to the readiness of professional development of teachers. Therefore, specific PD programs are essential when preparing teachers for the implementation of STEAM exhibits. Ritz & Fan (2015), noted that as such programmes must extend beyond the traditional training discourse and aims at enriching teachers' interdisciplinary knowledge base particularly in the inquiries and projects-oriented setting. These strategies are in line with the STEAM objectives of promoting problem solving, imagination and entrepreneurship. STEAM and IB PYP both involve the integration of knowledge through inquiry-based learning. However, implementing this approach entails changes of the traditional paradigm of teaching that relies on the knowledge-delivery method. Herro, Quigley, and Cian (2018), have also pointed out that teachers require professional development education to help learners to pose questions, investigate and provide solutions to issues that are generic and discipline based. This means that the professional development programs for teachers to include both content knowledge

about the specific disciplines and pedagogical practices that foster interdisciplinary work (Shatunova et al., 2019). Moreover, Colucci-Gray et al. (2019) pointed out that including arts within STEM learning, which is at the root of STEAM, enable creativity, critical and creative thinking, innovation in today's educational environment.

In Saudi Arabia, professional development can only take place within a cultural, technological and institutional framework. For example, Bin Othayman et al. (2022) and Gryson et al. (2024) argue for the constant engagement in PD that enhances the interdisciplinarity of teachers and contextually relevant. In addition, a study by Al Mulhim (2014), that endorses the call for addressing barriers to technology integration by engaging in effective teacher training. Furthermore, Alswilem (2019), points out that teachers have to be provided with ongoing professional development to learn to use ICT correctly when teaching, which is crucial when incorporating STEAM education provided the technology involved in coding and robotics.

A professional development has to be continuous in its execution and should match the setting where learning is happening. As highlighted by Ammar, Al-Thani, and Ahmad (2024), the authors stated that to increase innovation in STEM, it is important to focus on a concept that incorporates the learning support that is systematic, and supports the continual professional development rather than perfunctory workshops. By implementing this approach, educators are not only provided with theoretical knowledge but also with practical tools that will enable them to effectively implement STEAM education in the context of the current and future needs of students in Saudi Arabia and other countries.

2.6.2 Collaborative Planning Among Teachers

Coordination of the teachers is important to ensure the successful implementation of STEAM in the classroom under the framework of the IB PYP. This model promotes cross- curricular teaching because it allows the teachers from different fields to collaborate with each other as they develop the lessons to be used in the classroom. According to Wells (2019), when teachers plan lessons together, STEM and other subjects are not taught separately but are integrated to make it easier for the students to understand. Such collaboration enhances the overall learning experiences as students are able to find ways of using knowledge and skills from different disciplines to tackle practical problems.

As for the Riyadh schools, Alqassem, Dashash, & Alzahrani (2016) offer examples of how teachers can work together. It provides examples of how teachers in Saudi schools have engaged in synergistic efforts to create interdisciplinary projects that are well in line with the concept of STEAM education. For example, the science and arts teachers have crafted lessons that involve students in building environmentally sound structures while incorporating knowledge of engineering and invention. It also serves to strengthen the social relations between educators and facilitate the process of making learning more engaging for the students.

On the other hand, there are still questions and concerns related to institutional support and time allocation for collaborative planning. According to Gryson et al., (2024), schools need to make sure that teachers are physically determined in collaborative remanufacturing, planning, and reflecting interdisciplinary work. Therefore, it is important to strengthen concepts which focus on the principles of team work and collaboration among teachers through professional development programmes. It has also been linked with improved teacher confidence and performance in teaching STEAM content because of the cooperative nature of addressing instructional matters. Therefore, it is essential to embrace the idea of team planning in the enhancement of the overall and comprehensive STEAM curriculum that can facilitate learning among learners in various disciplines.

2.6.3 Investing in Technological Infrastructure

To effectively implement advances in STEAM learning in schools, a significant investment in technological resources is necessary. Technological support such as robots, coding platforms, and 3D modeling aids in the attainment of the hands on, inquiry-based learning that is embraced in the implementation of STEAM. STEM Revolution (2018), has identified that these technologies enhance students' engagement with the content as well as foster the construction of problem- solving, creative, and collaborative skills. As more and more schools and teachers integrate digital tools into their classrooms, it has become crucial for schools to have the necessary facilities to facilitate these uses.

In Saudi Arabia, the use of these technologies is suitable for the Vision 2030 objectives that are linked to the enhancement of students learning for the purposes of creating jobs in science, technology, and innovations. Mansouri and Al-Hamadi (2018), discussed that despite these goals, schools still face constraints in their ability to access and implement the necessary technology.

Challenges such as inadequate funding, inadequate training, and dated facilities are part of the reasons why STEAM education is not well practiced in many classes in Saudi Arabia.

Researchers found that incorporating technology into learning improved student engagement and creativity. According to PricewaterhouseCoopers (2016), Virtual Reality (VR), Artificial Intelligence (AI), and coding applications can be used effectively in the learning process by making it more tangible. Virtual Reality (VR), Artificial Intelligence (AI), and coding applications aid students in their learning process by enabling them to engage with, experiment with, and reason through concepts and theories that conventional learning helps may not easily comprehend. Moreover, Dubie (2024), explained that ICT helps to integrate other subjects where students create 3D art in art class using engineering principles.

To ensure that STEAM education is effective and beneficial, schools are required to spend extra resources on tools and facilities necessary for carrying out the provisions of these programs. This encompasses not only the acquisition of devices but also the provision of sufficient equipment for teachers to effectively use technology in their teaching (Al Mulhim, 2014). It is only through such investments that Saudi schools can overcome the existing obstacles and offer students the modern, practical learning experience that the STEAM education model offers.

2.7 Local and Global Perspectives on STEAM Integration

2.7.1 Global Trends in STEAM Education

STEM and STEAM education has now spread all across the globe due to the measures adopted by different governments to promote creativity and to prepare students for the future occupations. For example, the National Science and Technology Council (2013), synthesised a broad framework to facilitate STEM schooling in the United States, and is necessary for the preservation of the country's economic outlook and international status. The report stressed the STEAM curriculum for all levels of education for it prepares learners for the job market in technologies, health care engineering industries, among others.

STEM education that includes the study of science, technology, engineering, arts, and mathematics has been on the rise as a technique of fostering creativity and innovative thinking. There has been the Common Core State Standards Initiative that has called on the education systems to devise learning systems that will foster critical thinking, creativity, and collaboration

skills which are applicable in the current society. Some of the countries that have adopted the STEAM curriculum are South Korea and Finland where students get to practice various exercises that involve various creative aspects. For example, in South Korea, each school was encouraged to develop a curriculum that integrates engineering and arts to provide a stimulating learning environment and help students transfer the knowledge into various contexts (Shatunova et al., 2019).

In addition, the European Union has highly supported STEAM education through different programs such as Horison 2020 that aims to promote research and innovation in learning institutions (Ammar, Al-Thani & Ahmad, 2024). These include efforts to align education and training to industry needs and provide students with the appropriate technical and creative skills that will help them thrive in the changing world. Also, countries such as Australia have adopted STEAM as part of their national educational policies to educate students on creativity and innovation for the future workforce (Blackley & Howell, 2019).

On the other hand, Saudi Arabia is shifting its educational changes with the international standards by using strategies like Vision 2030 where education system is to be changed by implementing STEM and STEAM education. As stated by Khair (2024), these changes are important to equip students to become active members of a knowledge-based economy, create new knowledge and tackle the technological challenges of tomorrow. This shift in focus in the global curriculum towards STEAM education is in recognition of the fact that it is necessary to combine science with arts to prepare students for the workplace of the future. The implementation of STEAM curriculum has been seen to enhance students' participation and performance especially in subjects that cut across many disciplines (Honey & Kanter, 2013). These global movements are beneficial in the context of the educational system in Saudi Arabia as they present potentials for the integration of STEAM into the curriculum in response to the demands of the future generations.

2.7.2 Local Implementation in Riyadh Schools

In Riyadh, the implementation of STEAM within the context of the IB PYP is also increasing as more schools aim to meet the international standards and the requirements of the Saudi Arabian educational system. For example, the implementation of STEAM in different schools in Riyadh has been applied to address critical thinking, innovation, and cooperation among the young students (Alqassem, Dashash, & Alzahrani, 2016). These schools have adopted project-

based learning system that encompasses arts alongside the conventional STEM subjects providing a well-rounded education that fosters creativity under the umbrella of the IB PYP curriculum.

For example, one school in Riyadh initiated a STEAM project focusing on robotics, coding, and art where students had to design and build the robots and program them to perform in a storytelling art show. This type of interdisciplinary activity not only captures the interest of students but also fosters technical and creative abilities, which are valuable in the current job market (Shatunova et al., 2019). Such local implementations reflect the growing appreciation of the importance of STEAM education as the means of preparing learners for the world of work in the context of the emerging transforming economy.

However, the process of integrating STEAM in schools in Riyadh also has certain difficulties. Cultural beliefs, especially as regards to the roles of girls in STEM and STEAM may also be a cause of the girls not becoming fully engaged in the subjects. Although Saudi Arabia has achieved moderate success in enhancing women's education and participation of women in STEM education Saudi Arabia, there are cultural barriers that may prevent women from being fully engaged (Almogbel 2015). However, there is a problem in resources that is another major concern as follows: The challenge is that many schools in Riyadh lack adequate technology means, such as programming languages or 3D modeling tools to help them operate under STEAM projects (Mansouri & Al-Hamadi, 2018). These tools are normally expensive and the schools need to find ways in which they are going to benefit from the limited resources available to them.

However, the studied Riyadh schools continue to enhance the implementation of STEAM in the IB PYP curriculum. As these schools strive to align their education systems with those of other global schools, they are also able to incorporate local factors, thereby enhancing their ability to provide the best and most inclusive education system. shifts have also brought about other changes, such as the implementation of Saudi Arabia Vision 2030, which has mandated reforms in the education sector to prepare students for a knowledge-based society (Khair, 2024). This ongoing evolution signifies a continued effort to popularise the concept and practice of innovation and creativity within the Saudi education context, despite the challenging environmental conditions.

2.8 Gaps in the Literature and Future Directions

The cognition of the integration of STEAM in Riyadh schools and IB PYP has been explored in this study and the following areas of knowledge gaps have been identified. Perhaps the largest gap in the present literature is the room preventing any studies that recognise the impacts of STEAM-IB PYP implementation on students' accomplishment in Saudi Arabia in the long run. Though, the longer-term impacts of STEAM regarding higher order thinking ability, problem solving, and employment readiness of students, have not been effectively explored beyond the short-term and case study research approach (Shatunova et al., 2019). Longitudinal findings could offer a clearer understanding of the students' academic and occupational trajectory after the integration of STEAM-IB PYP in the context of the global economy.

There is also a significant dearth of data considering sustainable models of teacher training and professional development. According to various studies made in Riyadh, it has emerged that the majority of teachers lack effective training to teach STEAM subjects (Alqarni & Bashireh, 2022; Turkle & Wysocki, 2023). However, there is limited literature on the best practices that need to be adopted in proogramming teachers for interdisciplinary knowledge and competencies that are required for the implementation of STEAM education within the context of the IB PYP despite the presence of professional development programs. More research should be carried out on these models of professional development to examine them in details and how progress can be maintained in the long run particularly in the third world.

Equally missing are research and studies on the curriculum, specifically the resources and funding devoted to the pursuit. However, it is also crucial to think about how these ideas can be substantiated to the context of the IB PYP program that is known to have intensified principles (Aldossari, 2018); The idea of incorporating STEAM curriculum in some schools in Riyadh is worth considering. Furthermore, the shortage of proper technology in the form of robotics, coding platforms as well as other advanced machines and models also pose as a barrier to the effective implementation of the model (Mansouri & Al-Hamadi, 2018). Further research could be conducted to identify such barriers and how these could be surmounted by looking at the possibility of sharing resources and mutual solidarity between the public and private sectors to champion STEAM in schools.

Moreover, a long-term analysis of the changes resulting from the integration of STEAM- IB PYP is necessary to illustrate the resurgence of this integration in Saudi Arabia. While the present study indicates enhanced creativity and motivation, the effects of technological integration in learning, including higher-order thinking skills and career readiness, require further research (Khair, 2024). This study has the potential to enhance the current STEAM education approach and assist policymakers and educators in maintaining and enhancing its significance and effectiveness in achieving the objectives of Saudi Vision 2030.

2.9 Conclusion

The purpose of this literature review was to establish previous studies relevant to the integration of STEAM into the Riyadh schools after the adoption of the International Baccalaureate Primary Years Programme (IB PYP). Additionally, it presented STEM and STEAM approaches' background and evaluated the benefits of the latter, which encompasses critical thinking, creativity, problem-solving skills, and interdisciplinary learning. It also discussed the emerging move towards adopting STEAM to enhance innovation and cultivation of twenty-first-century competence.

However, there are certain challenges that might come up when implementing STEAM to IB PYP in Saudi Arabia particularly in the schools based in Riyadh. The following are some of the risks Teachers on the spot, lack of professionalism in professional development, clash between STEAM concept and the IB PYP assessment proforma and lack of resources. However, there is a very important issue that hinders the implementation of STEAM education in Saudi classrooms, and these are inadequate technological resources required for learning. However, the expected benefits of integrating STEAM-IB PYP suggest that potential benefits have several limitations in Riyadh schools, training teachers and developing a curriculum and resources for curriculum implementation. To address these issues, there is a need to embrace the essence of STEAM education to foster innovations and prepare students for careers in line with Saudi Vision 2030.

Chapter 3: Research Methodology

3.1 Introduction

This chapter outlined the research methodology used to examine the integration of STEAM within the IB Primary Years Programme (IB PYP) in Saudi Arabia's pioneering IB schools. The quantitative questionnaires and surveys were combined with qualitative interviews, filling the gaps with the educators' and experts' testimonies (Fakis et al., 2014). The type of research employed in the study was qualitative in a bid to grasp special issues, perceived benefits and effects of STEAM integration in inquiry-based learning based on the IB PYP framework. This study also provided adequate information about the research design and location, population and sample selection, data collection and analysis instruments, and the issue of ethical consideration in such a cohesive and well-coordinated manner that would ensure a valid outcome is obtained.

3.2 Research Philosophy

The research employed pragmatist research philosophy which aimed at finding practical solutions with regard to the fact that there exist numerical and non-numerical realities (Kaushik & Walsh, 2019). Therefore, the choice of pragmatism as the research paradigm in this study is useful in addressing the implementation of STEAM in IB PYP in Saudi Arabia since the method adopted combines both quantitative and qualitative paradigms because real life phenomena are complicated and do not consist of a single dimension. Both realism and instrumentalism, represent a context in which pragmatism is defined as what works or is suitable. Therefore, it can be used for determining how STEAM facilitates instructional practices and student learning within BPYP constructivist- based programming framework.

The Pragmatism is the consideration of the real-life application which emphasize on actual use of approaches rather than on a particular theory (Robson, 2024). This is a good practice in line with the use of mixed appraisal as a method that entails analysis of both quantitative data for instance survey data and qualitative data including expert interviews to be able to provide a better understanding on the integration of STEAM (Lopez 2023). Pragmatism also permits its concepts to be interpreted and applied, and is valuable for the examination of research data which pertains to educational research due to the different viewpoints which are crucial when assembling teaching actions.

3.4 Research Design

The research design used in this study was a mixed method research, which incorporates both quantitative and qualitative data to gain an overall view of the integration of STEAM in the IB Primary Years Programme (IB PYP) in the first Saudi Arabian schools to offer the IB curriculum. (Manzoor, 2020). This rationale was adopted because use of mixed-methods enables data triangulation and hence leads to increase reliability and richness of data obtained from both quantitative and qualitative methods. The questions were developed to measure quantative data regarding attitude, difficulty and improvement of the 19 IB PYP teachers because of the integration of STEAM. Furthermore, semi structured interviews with educational professionals expanded the knowledge of the study by providing concrete information on the experience and the problems of STEAM implementation within the context of IB PYP (Macharia, 2022). This design was particularly appropriate for this study since it gave the researcher an overall picture of the combination between STEAM and the IB PYP's inquiry based, transdisciplinary framework to enrich the schooling experience.

3.3 Research Approach

The current research to advance STEAM into IB PYP in the Saudi Arabian learning contexts, both inductive and deductive research methodologies can be valuable (Pandey, 2019). The use of the given inductive approach is quite beneficial in understanding how these educators receive and incorporate STEAM into teaching. In addition, based on the interviews with the teachers and their qualitative stories, the study will find out the main patterns and the crucial themes which are inextricably connected with the STEAM in IB PYP classrooms. It also allows the formulation of theories that are relatively concrete given experiences and observations from educators involved.

However, the deductive approach will be used to analyse hypotheses derived from literature concerning STEAM education and the IB PYP (Nori, 2024). Surveys will provide measurable variables regarding attitudes, perceived barriers, and perceived effects of integration of STEAM. Upon receiving the results, the study will either support or refute the formulated hypotheses. Therefore, the study will use both quantitative and qualitative approaches to provide a comprehensive integration of the findings of change in IB inquiry-based learning due to STEAM integration in Saudi Arabian schools (JAWAD, 2021).

3.5 Research Setting

The research was conducted at two prominent IB schools in Riyadh, Saudi Arabia, which are recognized as pioneers of IB education in the country. In the case of this research, these institutions are the pioneers of IB education in the country. Therefore, they are the best settings to study the relationship between IB PYP and STEAM education. These two schools have perhaps more extensively employed inquiry-based learning and innovation in their curriculums.

3.6 Population and Sampling

3.6.1 Target Population

The target participants tasked with the implementation of IB PYP were teachers from the selected pioneered IB schools in Riyadh. Therefore, they were in a unique position to offer information and experiences on how STEAM concepts were being incorporated in their practices. Also, the participants were chosen based on educational background with focus on IB PYP program and experiences in STEAM integration. These experts included curriculum developers, academic supervisors, and educational administrators who engaged in implementing or facilitating STEAM practices in IB PYP contexts. These groups provided a multiple-perspective view of integrating STEAM in education.

3.6.2 Sampling Strategy

The study adopted purposive sampling technique that was used to identify and recruit the IB PYP teachers from both selected IB schools. The inclusion criteria were used in selecting eligible participants through consideration of the above criteria. The teachers must have taught in the IB PYP for at least three years, and teachers should have prior exposure to STEAM integration. In the case of the educational experts, the research employed snowball sampling, starting with contacts acquired through professional connections. Then, they suggested that other professionals in the area be reached further. 100 selected IB PYP teachers from the two chosen IB schools, while the number of experts to be interviewed ranged between 5 and 6.

3.7 Data Collection

3.7.1 Surveys

A structured survey instrument (Appendix) was used to gather data from IB PYP teachers

in the chosen IB PYP schools. Some of the areas of concern of the survey included the knowledge of the teachers on STEAM education and their understanding of the implementation of STEAM education in the context of the IB PYP. It also explored the issues that pertain the integration of STEAM within the context of inquiry-based learning-teaching model. Also, the survey captured the perceived effect of the MOOCs on the student learning outcomes specifically in terms of creativity, problem solving, and critical thinking. It focused on the professional development needs required to help teachers facilitate the implementation of STEAM. The survey involved both closed-ended questions such as those using Likert scales and open-ended questions aimed at achieving quantitative analysis as well as qualitative insights**.**

3.7.2 Semi-Structured Interviews

An interview was carried out with particular professionals who have experiences in implementing STEAM in the IB PYP framework. The interviews provided the researcher with an insight into the most effective strategies for the integration of STEAM within the context of the IB PYP. It also includes the philosophical foundation of STEAM and IB PYP integration, which emphasises segmented curriculum and teacher preparation to work effectively in the setting. Further, the interviews revealed how STEAM corresponded to the trans disciplinary themes of the IB PYP. Interviews were conducted either face-to-face or through video *conferencing and took* roughly 60 minutes each country**.**

3.8 Data Analysis

3.8.1 Quantitative Data (Surveys)

The quantitative data collected from questionnaires were descriptive statistics that highlighted the patterns, mean and occurrences of the teachers' responses towards the implementation of STEAM education in the classroom. The Likert-scale responses sought to determine teachers' perception of the effectiveness of STEAM in improving students' achievements, understand the difficulties of integrating the concept in the IB PYP, and identify the support and assistance teachers considered necessary for appropriate STEAM implementation. Data analysis involved using statistical tests like descriptive statistics to determine the mean scores of each survey category and cross-tabulation that examined the variables such as the number of years a teacher has been in service and their attitudes towards STEAM.

3.8.2 Qualitative Data (Interviews)

The thematic analysis method was applied to analyse the qualitative data collected from the interviews. This process included the conversion of all interviews into texts for textual Content Analysis, which enriched the analysis. All the aspects such as challenges, opportunities, engagement in curriculum design, and supportive factors emphasising on STEAM integration in the IB PYP were categorised into some of the key themes. It also involved of finding out whether responses contained similar patterns or differences which were consistent with

the answers from different experts. To ensure valid and reliable results, triangular validation was conducted whereby the findings of the qualitative study were compared with the survey results. The analysis of the qualitative data that I collected complemented the quantitative results by giving us an additional layer of understanding of the issues at hand and suggestions on how to address them in practice.

3.9 Validity and Reliability

To enhance validity, instruments of the survey were first analysed by curriculum experts from the selected two IB PYP schools in Riyadh before administration. Therefore, the purpose of this review was to ensure the questions addressed the research objectives correctly and included questions for all aspects of integrating STEAM in the IB PYP. Further, a pilot test was done using teachers to ensure that the items in the survey were more relevant. The reliability of the data collection instruments was maintained through using standard procedures for both the surveys and the interviews (Jain, 2021). Test-retest reliability was also determined on a small sample of the teachers, through re-administration of the survey after sometime but within a short period of time to determine the reliability of the scores obtained**.**

3.10 Ethical Considerations

There were certain ethical concerns with this research. All the participants provided informed consent to take part in the study after being given clear information about its objectives, data collection, processes, and their right to withdraw from the study (Dankar et al., 2019). It is for this reason that consent forms were obtained before participation to avoid any misunderstanding. There was also an emphasis on participants' identity; individuals were not identified, and all data were secured in a manner that particular answers could not be associated with the respondents. Furthermore, data security was assured by memorising the responses to surveys and recordings of interviews, and only the researcher and supervisors had access to such information**.**

3.11 Limitations

There were some limitations to the study, and these are important to note. Firstly, the study was conducted in two schools within Riyadh only and both schools have been nominated as a pioneer in the adoption of IB PYP and improvement of STEAM. Therefore, the conclusions are restricted by transferability and applicability to other educational environments and institutions, which differ significantly from the given ones (Pan, 2020). However, there might be an influence of bias in the results presented by interviewees because it states only the views of certain experts. However, to overcome this limitation, an additional analysis was performed to compare and contrast the qualitative data that was gathered from the students and teachers to quantitative data from an online survey which provided a balance to the implementation of STEAM in the IB PYP.

Chapter 4: Data Analysis and Discussion

4.1 Introduction

In this chapter, the results of the interviews with the teachers regarding STEAM education in the framework of the IB PYP are presented. In the course of analysing the responses, some of the themes that emerged include the perceived advantages of STEAM education, challenges faced as educators implemented it in class, preparation and resources. The implications aim at providing insight into the teachers' perception of STEAM education in relation to the learners in of IB PYP and various factors that hinder theeffective implementation of STEAM education.

4.2 Frequencies

Statistics

Gender			Age	Teaching Experience	Teaching Grade Level
N	Valid	100	100	100	100
	Missing	0	0	0	0

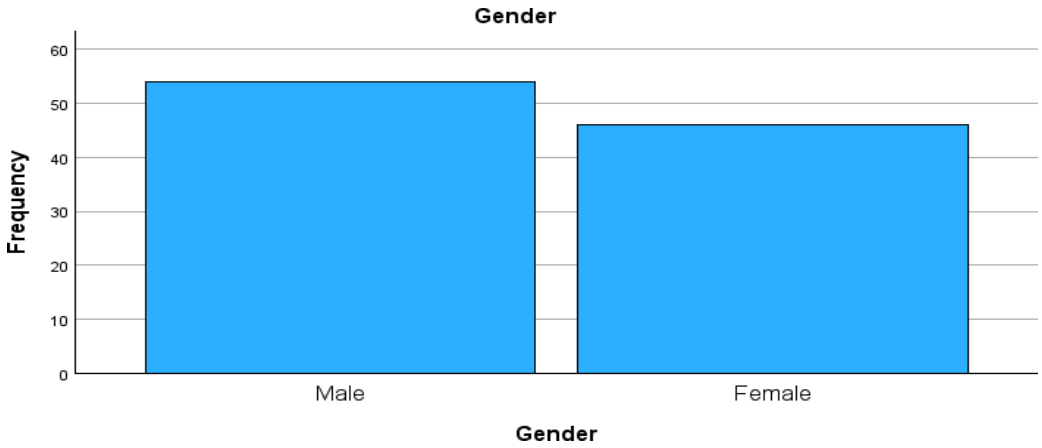
As displayed in the frequency analysis table, all Data for Gender, Age, Teaching Experience, and Teaching Grade Level were obtained from 100 respondents with no missing values in any of the category. This means that the data collected is complete hence enhancing its reliability in the analysis that shall be conducted in this study. This uniformity regarding all the variables proved helpful since the subsequent statistical analysis would rely on these results.

Gender

Frequency			Percent	Valid Percent	Cumulative Percent
Valid	Male	54	54.0	54.0	54.0
	Female	46	46.0	46.0	100.0
	Total	100	100.0	100.0	

Table 1 Frequency of Gender

The above Table 1 shows the frequency distribution of gender among the 100 respondents. The data shows that 54% of the participants are male, while 46% are female. This relatively balanced distribution ensures that both male and female perspectives are well-represented in the survey, reducing potential gender bias in the analysis. The nearly equal gender split also provides an opportunity to explore whether gender differences influence responses, particularly in areas such as perceptions of curriculum effectiveness and teacher preparedness. The inclusion of both genders at comparable rates allows for a more comprehensive understanding of the educational context being studied.

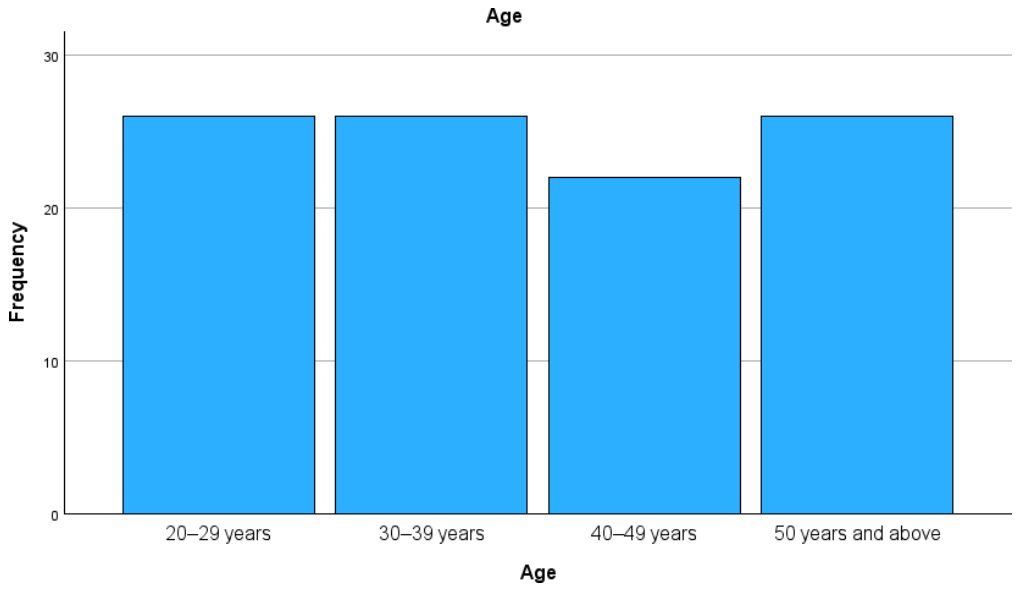


Age

Frequency			Percent	Valid Percent	Cumulative Percent
Valid	20–29 years	26	26.0	26.0	26.0
	30–39 years	26	26.0	26.0	52.0
	40–49 years	22	22.0	22.0	74.0
	50 years and above	26	26.0	26.0	100.0
	Total	100	100.0	100.0	

Table 2 Frequency of Age

The above table 2 shows the age distribution of the 100 respondents. The data is evenly split among three age groups: 26% of participants are aged 20–29 years, another 26% are aged 30– 39 years, and 26% are 50 years and above. The 40–49 years group represents 22% of respondents. This diverse age representation ensures a wide range of experiences and perspectives, which is beneficial for understanding the impact of age on educational practices and perceptions.



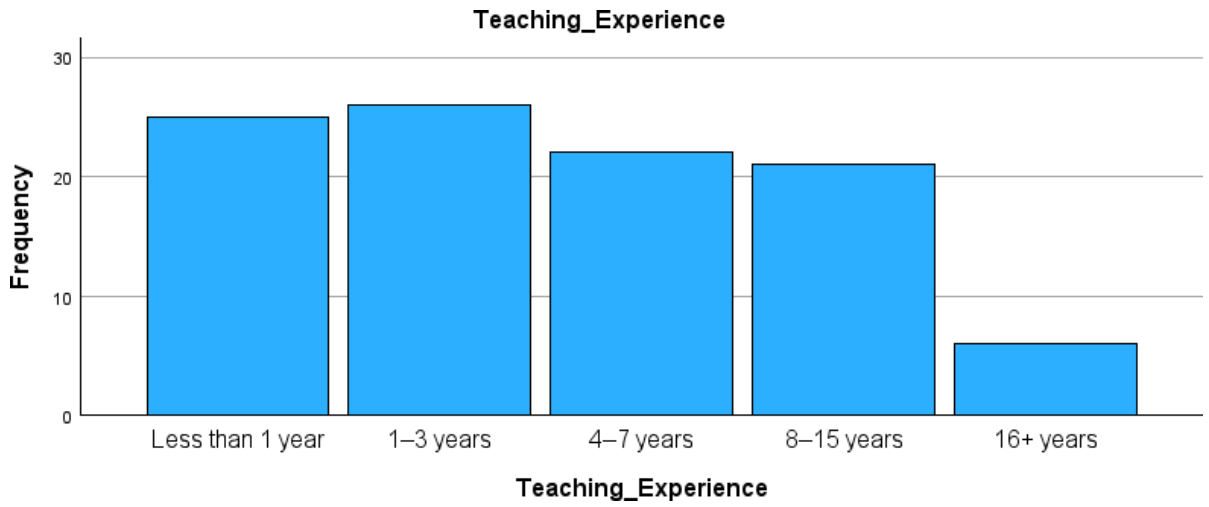
Teaching Experience

Frequency			Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	25	25.0	25.0	25.0
	1–3 years	26	26.0	26.0	51.0
	4–7 years	22	22.0	22.0	73.0

	8–15 years	21	21.0	21.0	94.0
	16+ years	6	6.0	6.0	100.0
	Total	100	100.0	100.0	

Table 3 frequency of Teaching Experience

Table 3 presents the teaching experience of the respondents. The majority of participants have 1–3 years of experience, accounting for 26% of the total. Another 25% have less than 1 year of teaching experience, reflecting a significant number of newcomers to the profession. Respondents with 4–7 years of experience make up 22%, while those with 8–15 years constitute 21%. The most experienced group, with 16+ years, represents only 6%. This distribution indicates a relatively young and mid-career teaching population, with fewer highly experienced educators contributing to the survey.

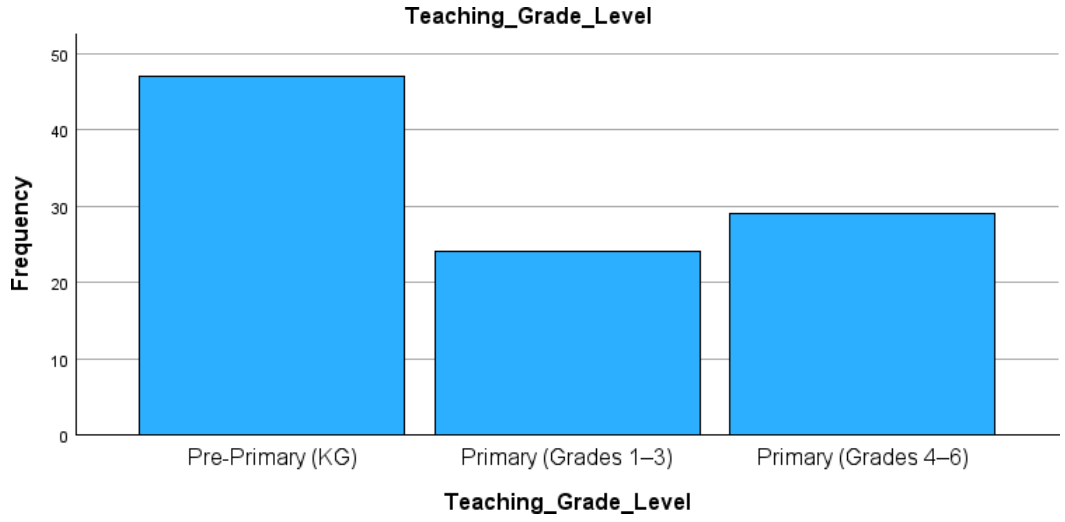


Teaching Grade Level

Frequency			Percent	Valid Percent	Cumulative Percent
Valid	Pre-Primary (KG)	47	47.0	47.0	47.0
	Primary (Grades 1–3)	24	24.0	24.0	71.0
	Primary (Grades 4–6)	29	29.0	29.0	100.0
	Total	100	100.0	100.0	

Table 4 Frequency of Teaching Grade Level

Table 4 shows the distribution of teaching grade levels among the respondents. The largest group, comprising 47%, teaches at the Pre-Primary (KG) level, indicating a significant focus on early childhood education in this sample. Teachers handling Primary Grades 1–3 make up 24% of the respondents, while those teaching Primary Grades 4–6 account for 29%. This distribution reveals that nearly half of the respondents are involved in foundational education, with a balance between lower and upper primary grades. The spread across these grade levels reflects a diverse range of teaching responsibilities, from early childhood to upper primary.



4.3 Descriptive

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
I am familiar with the concept of STEAM education	100	1.00	5.00	2.7700	1.33979
I believe that integrating Arts into STEM (STEAM) is essential for holistic student development.	100	1.00	5.00	2.6900	1.35360
The current IB PYP curriculum allows for the effective integration of STEAM.	100	1.00	5.00	2.6700	1.37109
It is challenging to assess creativity and interdisciplinary learning outcomes in STEAM within the IB PYP framework.	100	1.00	5.00	3.1000	1.34465
The main challenge in integrating STEAM with IB PYP assessments is the lack of standardised tools.	100	1.00	5.00	3.3200	1.36241
I feel adequately prepared to teach STEAM subjects in my classroom	100	1.00	5.00	3.0800	1.36093

Thesis

I believe that ongoing professional development is crucial for effective STEAM integration.	100	1.00	5.00	3.1400	1.36345

My school provides sufficient technological resources (e.g., robotics, coding platforms) for STEAM activities.	100	1.00	5.00	3.0000	1.33333
I regularly collaborate with other teachers to create interdisciplinary STEAM lessons.	100	1.00	5.00	3.3700	1.33829
Valid N (listwise)	100				

Table 5 Descriptive

Table 5 presents descriptive statistics for respondents' perceptions of STEAM integration within the International Baccalaureate Primary Years Programme (IB PYP). The table shows responses for ten key statements, each rated on a 5-point Likert scale. The means range from 2.67 to 3.37, indicating varying levels of agreement among the participants.

The statement, "The main challenge in integrating STEAM with IB PYP assessments is the lack of standardised tools", has the highest mean score (M = 3.32), suggesting that respondents acknowledge the difficulty in aligning STEAM with the IB PYP's assessment standards. In contrast, the statement, "The current IB PYP curriculum allows for the effective integration of STEAM", has a lower mean (M = 2.67), reflecting some skepticism about the curriculum's compatibility with STEAM approaches.

Notably, respondents show moderate levels of confidence in their preparation for teaching STEAM subjects (M = 3.08) and place importance on professional development for successful STEAM implementation (M = 3.14). On average, teachers also report regular collaboration with colleagues to create interdisciplinary STEAM lessons (M = 3.37), which aligns with research suggesting that teacher collaboration enhances interdisciplinary learning. While there is recognition of the need for professional development and collaboration, the data reveals concerns about assessment challenges and technological resource availability for effective STEAM

integration. The standard deviations, ranging from 1.33 to 1.37, indicate a moderate spread of opinions, with respondents expressing diverse perspectives on these issues.

4.4 Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Teacher Preparedness[b]	.	Enter

a. Dependent Variable: Perception_of_Curriculum_Effectiveness

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.245[a]	.060	.051	1.33600

a. Predictors: (Constant), Teacher Preparedness

Table 6 Regression

Table 6 displays the results of a regression analysis examining the relationship between Teacher Preparedness (independent variable) and Perception of Curriculum Effectiveness (dependent variable). The model summary indicates an R-value of 0.245, suggesting a weak but noticeable correlation between teacher preparedness and how effective teachers perceive the curriculum to be in integrating STEAM.

The R-Square value of 0.060 implies that about 6% of the variance in perceptions of curriculum effectiveness can be explained by teacher preparedness. While this is a relatively low proportion, it highlights that teacher preparedness plays a role in shaping perceptions of curriculum effectiveness, albeit modest. The adjusted R-Square of 0.051 accounts for potential overfitting, confirming that the model still explains approximately 5.1% of the variance when generalised to the broader population.

The Standard Error of 1.336 represents the average distance that the observed values fall from the regression line, reflecting the variability in teachers' perceptions. The model's results emphasise the importance of teacher readiness in shaping perceptions of the curriculum's ability to integrate STEAM effectively. However, since the R-Square is low, other factors, such as resource availability, professional development, and collaboration with peers, likely play significant roles in determining how effective teachers view the curriculum. It suggests that while teacher preparedness is important, it may need to be complemented by other factors to enhance curriculum effectiveness in STEAM integration within the IB PYP framework.

4.5 ANOVA

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11.190	1	11.190	6.269	.014[b]
	Residual	174.920	98	1.785		
	Total	186.110	99			

a. Dependent Variable: Perception_of_Curriculum_Effectiveness

b. Predictors: (Constant), Teacher Preparedness

Table 7 ANOVA

The above table 7 presents the Analysis of Variance (ANOVA) results for the regression model examining the impact of Teacher Preparedness on Perception of Curriculum Effectiveness. The regression model yielded a Sum of Squares of 11.190, indicating the variability explained by the model, while the Residual Sum of Squares was 174.920, representing the unexplained variability.

The Mean Square for Regression was calculated at 11.190, and the Mean Square for Residuals at 1.785. The resulting F-value of 6.269 indicates that the model significantly predicts the dependent variable, with the associated p-value (Sig.) of .014, which is below the conventional threshold of 0.05. This significance suggests that there is a statistically significant relationship between teacher preparedness and perceptions of curriculum effectiveness. The ANOVA results confirm that teacher preparedness plays a crucial role in influencing educators' perceptions of how effectively the curriculum incorporates STEAM education within the IB PYP framework.

Coefficients[a]

Model		Unstandardised Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	3.444	.337		10.225	<.001	2.776	4.113
	Teacher Preparedness	-.247	.098	-.245	-2.504	.014	-.442	-.051

a. Dependent Variable: Perception_of_Curriculum_Effectiveness

The above table displays the coefficients from the regression analysis, highlighting the relationship between Teacher Preparedness and Perception of Curriculum Effectiveness. The unstandardised coefficient (B) for the constant is 3.444, suggesting that when teacher preparedness is zero, the baseline perception of curriculum effectiveness is at this value.

The coefficient for Teacher Preparedness is -.247, indicating a negative relationship; as teacher preparedness increases, perceptions of curriculum effectiveness decrease. The standardised coefficient (Beta) of -.245 further quantifies this relationship, emphasising its relative strength.

The t-value of -2.504 and p-value (Sig.) of .014 confirm the statistical significance of the finding, suggesting that enhanced teacher preparedness may be associated with lower perceptions of curriculum effectiveness. The 95% confidence interval for the B coefficient ranges from -.442 to -.051, indicating that the negative effect is consistent and statistically reliable.

4.6 Correlation

Correlations

		Perception_ of_Curricul um_Effecti veness	Professiona l Developme nt	Teacher Preparedne ss	Collaborati on with teachers
Perception_of_Curriculum_Effectiveness	Pearson Correlation	1	.117	-.245*	-.032
	Sig. (2-tailed)		.246	.014	.753
	N	100	100	100	100
Professional Development	Pearson Correlation	.117	1	.081	.078
	Sig. (2-tailed)	.246		.423	.441
	N	100	100	100	100
Teacher Preparedness	Pearson Correlation	-.245*	.081	1	-.007
	Sig. (2-tailed)	.014	.423		.949
	N	100	100	100	100
collaboration_with_teachers	Pearson Correlation	-.032	.078	-.007	1
	Sig. (2-tailed)	.753	.441	.949	
	N	100	100	100	100

*. Correlation is significant at the 0.05 level (2-tailed).

Table 8 Correlations

Table 8 presents the correlation coefficients between Perception of Curriculum Effectiveness, Professional Development, Teacher Preparedness, and Collaboration with Teachers. The correlations are assessed using Pearson's correlation coefficient, providing insights into the relationships among these variables. The correlation between Perception of Curriculum Effectiveness and Professional Development is .117, which is not statistically significant ($p = .246$). This indicates that perceptions of curriculum effectiveness do not significantly change with professional development.

A notable finding is the negative correlation of -.245 between Perception of Curriculum Effectiveness and Teacher Preparedness, which is significant (p = .014). This suggests that as teacher preparedness increases, perceptions of curriculum effectiveness decrease. This inverse relationship may indicate that higher levels of preparedness could lead to critical evaluations of the curriculum's effectiveness. The correlation between Teacher Preparedness and Collaboration with Teachers is negligible at -.007, with a p-value of .949, indicating no significant relationship. Similarly, the correlation between Professional Development and Collaboration with Teachers is also minimal (.078), showing a lack of association. These findings highlight significant areas for further investigation, especially the intriguing negative correlation between teacher preparedness and curriculum perception.

4.1 Thematic Analysis

4.1.1 Introduction

STEAM or Science, Technology, Engineering, Arts Sciences, & Mathematics in the context of the IB Primary Years Programme (IB PYP) is a major concern of educators at present. This thematic analysis is therefore based on data obtained from 6 teachers throughout their interviews as well as their opinions and experiences on STEAM education. Through the analysis of these qualitative data, the following patterns are identified that highlight the importance of STEAM for the comprehensive students' successful growth. Furthermore, this analysis provides an understanding of the challenges that a teacher experiences when trying to integrate the proper STEAM approaches. This knowledge is crucial in developing future directions for enhancing the implementation of STEAM in the context of the IB PYP framework.

4.1.2 Theme 1: Understanding and Value of STEAM Education

This theme explores how educators perceive the notion of STEAM education by posing questions regarding the significance of the idea to cater for the students' comprehensive development and the impact of the strategy on the understanding of a subject content. Incorporation of arts into various topics in STEM fields is in general considered useful for

enhancing students' imagination and imagination. Some of the questions posed to participants were the level of awareness they had about STEAM and how useful they perceived the idea to be in learning. It obtained general acknowledgement, favourable perceptions in addition to some types of challenge and interest in the use of the programme.

According to Participant 1:

" STEAM integration in an IB PYP setting is a holistic approach to education that seamlessly combines Science, Technology, Engineering, Arts, and Mathematics into a cohesive and meaningful learning experience. It goes beyond simply teaching these subjects separately and focuses on fostering interdisciplinary connections and real-world applications. "

The key characteristics of STEAM integration in IB PYP include:

- *Inquiry-based learning: The IB PYP's core principle of inquiry-based learning is central to STEAM integration. Students are encouraged to investigate real-world problems and questions, using their creativity and critical thinking skills to develop solutions.*
- *Transdisciplinary themes: STEAM projects often revolve around transdisciplinary themes that connect different areas of knowledge. This helps students see the big picture and understand how different disciplines work together.*
- *Hands-on experiences: STEAM integration emphasises practical, hands-on activities that allow students to experiment, create, and problem-solve. These experiences help to solidify learning and make the subject matter more engaging.*
- *Collaboration and communication: STEAM projects often involve teamwork and collaboration, providing students with opportunities to develop essential communication skills and learn from each other.*
- *Real-world connections: STEAM integration connects classroom learning to real-world applications, helping students see the relevance of their studies and understand how they can contribute to society."*

The response is useful in that it underscores the generalised approach that the present study adopts in regard to STEAM integration in the context of the IB PYP framework. Through questioning and exploration, it respects students' active participation in seeking and finding solutions of practical problems, which encourages innovative solutions. The reference to transdisciplinary themes can be used to demonstrate how STEAM projects help students find relationships between disciplines and contribute to the development of a better understanding of the connections between subject matters (Mejias et al., 2021).
Moreover, it is necessary to highlight the significance of practical sessions as practical activities not only explain the concepts but also make the students more interested and engaged in the learning process. Interdisciplinary integration and cooperation are rightly pointed out as important parts of STEAM, as well as discussing the possibilities of teamwork in further activities. It emphasis on the real-world relationships means that education becomes meaningful to students, as the associations between academic pursuits and society are underlined. However, the response could use some elaboration on the issues that might arise in the process of STEAM integration, like the availability of resources or teacher training as it provides only positive spin (Ozkan & Umdu Topsakal, 2021).

Participant 2 shared a similar sentiment but noted challenges in implementation:

Thesis

““I understand STEAM as an educational approach that merges science, technology, engineering, arts, and math. It’s important because it helps students develop both analytical and creative skills. By integrating the arts, we encourage innovation and critical thinking, which are essential for students’ future success.”

This observation reflects a common issue in education, where understanding does not always lead to effective practice. As Liao (2019) points out, educators may struggle to create cohesive STEAM experiences. The recognition of these gaps signals the need for professional development and resources to enhance STEAM integration.

Participant 3 expressed a positive outlook about the core benefits of combining STEAM education with IB PYP? How does it enhance student learning.

“Combining STEAM (Science, Technology, Engineering, Arts, and Mathematics) education with the International Baccalaureate Primary Years Programme (IBYP) offers numerous benefits for student learning. Enhanced Student Learning

- *Holistic Development: STEAM integration aligns with the IB PYP’s focus on holistic development. By incorporating arts into STEM education, we create a more well-rounded learning experience that nurtures students’ creativity, imagination, and emotional intelligence.*
- *Meaningful Connections: STEAM education helps students see the interconnectedness of different subjects and how they relate to the real world. This can make learning more engaging and meaningful, fostering a deeper understanding of concepts.*
- *Enhanced Creativity and Innovation: The arts component of STEAM encourages students to think creatively and explore different perspectives. This can lead to more innovative solutions to problems and foster a lifelong love of learning.*
- *Improved Communication Skills: STEAM projects often involve teamwork and collaboration, providing students with opportunities to develop strong communication skills. These skills are essential for success in both academic and professional settings.*
- *Real-World Applications: STEAM education focuses on real-world applications, helping students see the relevance of their learning. This can increase motivation and*

engagement, as students understand how their knowledge can be applied to solve problems and make a difference Becker and Park (2011).”

The integration of STEAM education with the IB PYP framework indeed presents numerous advantages for student learning (Gürkan, 2021). It supports because that approach fosters imagination and empathy while teaching academics. Meaningful focus generates an interest to find relevance in every relation between students and knowledge. However, there are no considerations of possible issues, like resource constraints or teacher training to enhance achievement of intended objectives, provided in the response (Lukas & Yunus, 2021). What can be appreciated is the emphasis on creativity and innovation but this may be enhanced by demonstrating how this is realised in practice activities in class. It is possible to follow the logic of the argument, but there could be more fine-tuning to weigh up these factors.

Participant 6 provided a nuanced view, stating:

Combining STEAM education with IB PYP enhances student learning by promoting critical thinking, collaboration, and creativity. It encourages students to ask questions, explore concepts deeply, and apply their knowledge in practical contexts. This integration fosters a holistic understanding of the world, preparing students to tackle complex challenges in an increasingly interconnected society. The following response shows how the combination of STEAM education with the International Baccalaureate Primary Years Programme (IB PYP) poses a positive change. This integration enables a more active and research-based approach through critical thinking, collaboration and creativity. The participant states ‘The students are encouraged to ask questions and dig deeper into concepts which make them transition from passive learning to active learning.’ In addition, there is an increased focus on using content learnt in real-life situations, which determines the need to be relevant in a highly globalised society. This approach of learning is concurrent with the modern education goals of producing individuals who are well rounded and flexible (Ahmad et al., 2020).

4.1.3 Theme 2: Challenges and Barriers to Effective Implementation

This theme revolves around the problems and challenges that a teacher may face as he or she seeks to implement STEAM education. However, there is ample literature on the benefits of STEAM, teachers encounter a myriad of obstacles that do not allow for optimal implementation of enhancement. Some of these barriers are as follows, lack of the necessary resource may be required, lack of training, lack of time and last but not the least is organisational resistance to change. Based on the elements followed during the interviews, the aforementioned guiding criteria established a broad range of issues that define the participants' experience in enhancing the delivery of STEAM education.

One respondent noted:

"One of the biggest challenges we face is the lack of resources. We don't have enough technological tools or materials to effectively teach STEAM. Even when we have ideas for interdisciplinary projects, we can't always execute them because of these limitations."

This response raises a challenge that affects educators, as Mansouri and Al-Hamadi (2018) note, insufficient technological resources constrain STEAM programs' execution significantly. These children are unable to gain access to the tools and supplies that are crucial for providing students with valuable, engaging, and effective STEAM learning environments that incorporate

hands-on and inquiry-based opportunities.

Another participant shared his/her perspective about specific challenges related to teacher preparedness and the type of professional development do teachers need to effectively teach STEAM in IB PYP settings.

"One specific challenge is that not all teachers feel confident in their STEAM content knowledge or pedagogical approaches. Professional development should focus on interdisciplinary teaching strategies, hands-on project planning, and inquiry-based learning techniques. Workshops that provide practical examples and collaborative planning time can be particularly beneficial."

One of the issues is that many teachers reported low levels of confidence to deliver STEAM content and teaching strategies, and they may not be adequately equipped to teach across disciplines. There is a need to focus on professional development considering instructional practices that include interdisciplinary teaching approaches and inquiry learning models that are instrumental in supporting STEAM endeavors. However, the response could expand the description of those workshops to describe how exactly they would address the concerns of teachers in practice. For example, giving more information about the kinds of practical activities or brainstorming sessions would strengthen the research. Also, the indication supposes that every teacher needs this suggestion; while it is possible to adopt a more refined method that addresses teachers in terms of their training levels for more efficient professional development. In conclusion, it is acceptable to focus on the need to maintain teachers' confidence through purposeful professional development, though understanding strategies for implementation and teacher diversity could support the argument more profoundly (Ritz & Fan, 2015).

A third participant viewed about the challenges related to teacher preparedness and the type of professional development do teachers need to effectively teach STEAM in IB PYP settings.

According to the National Academies Press (2020) an effective professional development program would include a combination of activities designed to enhance teachers' content knowledge, pedagogical skills, and ability to integrate technology effectively. Some possible activities could include:

- *Workshops: Traditional workshops would be held to exchange best practices in STEAM education, offer new teaching methodologies, and give theoretical knowledge.*

- *Hands-on Experiments: To enhance their learning and gain practical experience, teachers would participate in hands-on experiments and activities linked to STEAM disciplines.*
- *Lesson Planning: Teachers would work together to create lesson plans and activities that promote creativity, critical thinking, and problem-solving abilities while incorporating STEAM ideas.*
- *Technology Integration: The sessions would concentrate on combining technology tools and resources into STEAM classes to improve student engagement and learning results.*
- *Peer Observations and comments: Teachers would be able to view their colleagues' classes, offer comments, and participate in reflective dialogues to improve their own teaching techniques."*

The about response stated that professional development strategies adequately and efficiently tackle major issues relating to preparing teachers for incorporating STEAM in the IB PYP. Through the use of theoretical content and practical demonstrations that mark the application of the theory through workshops and experiments, teachers provide the candidates with the theoretical background, which is crucial for increasing their confidence and empowering them through the subsequent constructive competence (Afalla & Fabelico, 2020). More importantly, planning sessions are crucial because there are always planning done as a group and the task involves developing activities that encourage creativity, thinking, and problem-solving skills, which are in line with the inquiry principles of the IB PYP. Technology integration sessions are similar in that it gives the educators the necessary tools so they can implement the technology tools appropriately, which is essential to capture the attention of the modern learners.

However, some benefits of peer observation and feedback entails improvement and professional development, some challenges like time and space may hamper teachers' ability to engage in frequent observation and feedback. Moreover, it is also noteworthy that these strategies may require a certain degree of customisation depending on the teachers' background in STEAM; this concern could be systematically mitigated if incorporated into the analysis that would, in turn, make these materials accessible and relevant to practitioners with diverse levels of expertise (Almogbel, 2015).

Another educator pointed out a challenge with assessment:

"My involvement with the International Baccalaureate Primary Years Programme (IB PYP) began 5 years ago when I joined a school that was transitioning to the IB curriculum. I started as a classroom teacher, where I had the opportunity to implement the IB PYP inquiry-based approach in my lessons. Over the years, I've also been involved in professional development workshops, curriculum reviews, and teacher training related to the IB PYP."

This comment further substantiates the challenges that teachers face when implementing STEAM into the IB PYP especially in relation to the assessments. While, STEAM is more often the results of an inquiry and creativity challenges the norms and standard assessment tools that are mostly conformist in their design. Aldossari (2018), emphasises, that these traditional models can reduce the benefits of STEAM defined by its broader and exploratory approach. As a result, teachers may experience the dilemma of promoting inquiry and at the same time teaching to more constricted curriculum standards due to the need of representing students' competencies and progress appropriately. This kind of misalignment may lead to disengagement, which stems from the belief that teachers and learners are not receiving proper value or recognition for creative accomplishments. Time constraints were significant issue raised by participants. One respondent explained:
"Time constraints are a big issue. With the curriculum being so packed, there's little room to experiment with new teaching methods like STEAM."

This statement points at a real-life limitation that many teachers encounter. According to Gryson et al. (2024) interdisciplinary teaching calls for time for planning and interaction across faculties. If there is no specifically appointed time to spend for STEAM activities, then, majority of the time, the practice of incorporation falls short of providing depth where learning becomes truly meaningful.

Management assistance, or the lack of it, was another issue touched on by participants. One educator commented:

"We often lack administrative support for STEAM initiatives. There is a disconnect between what the teachers want to implement and what the administration prioritises."

This observation also underscore the need for leadership to provide support for the practice

of innovative teaching approaches. According to Alqassem et al. (2016), effective leadership should always be encouraged in fostering education agenda such as STEAM. Lack of administrative support means that teachers themselves can be discouraged from following through with their STEAM project, rendering all such efforts useless.

A respondent highlighted the role of parental expectations as a barrier:

"Parental expectations and perceptions can also be a barrier. Some parents are not familiar with STEAM and may prefer traditional teaching methods, leading to pressure on teachers to revert to those methods."

There is need for more public participation and sensitisation on the importance of embracing STEAM education by reference to this comment. According to Liao (2019), one of the important prerequisites for successful implementation of STEAM is to raise awareness of parents and stakeholders with reference to its significance. Developing parental support is another intervention that may assist in cultivating the said improved climate for STEAM related programs allowing the educators to try out the new pedagogy with more confidence.

4.1.1 Theme 3: Strategies for Overcoming Challenges in STEAM Implementation

The strategies that have been put in place by educators as they attempt to surmount the various hurdles and obstacles to the execution of STEAM learning is the subject of this theme. Some of the areas mentioned by the participants in relation to implementation of limitations included; limited resource, inadequate training, and constrained curriculum but they shared different creative ways of implementing STEAM in classroom.

One participant highlighted the importance of adapting lessons with available resources:

""Assessing creativity is difficult because it's so subjective. While we can measure technical skills, creativity doesn't fit into a standard rubric. I often find myself

questioning how to fairly evaluate students' innovative ideas while also assessing their mastery of content in STEM subjects."

This strategy is in harmony with the third principal, resourcefulness, and the lack of technological tools is the reason for choosing this strategy. As Mansouri and Al-Hamadi (2018 explain, even if the teachers have very little resources a lot of creativity can be promoted when students are encouraged to use basic materials to solve problems.

Another participant emphasised the role of collaborative planning:

"The Key challenges include limited resources, varying levels of teacher preparedness, and the need for a flexible curriculum structure that accommodates interdisciplinary learning. Time management can also be a barrier, as teachers must balance the demands of the curriculum while integrating STEAM effectively."

This approach shows how teachers are engaging with teachers from other classes, subjects and this is also supported by Ritz and Fan (2015) who propose integration since it plays a key role in realising inter-disciplinary learning. Moreover, a third participant address the diverse learning needs of students (differentiation) in a STEAM-IB PYP integrated classroom.

In a STEAM-IB PYP integrated classroom, I address diverse learning needs by offering various entry points to projects, providing differentiated tasks, and using flexible grouping strategies. This allows students to engage at their own levels and encourages peer collaboration, enhancing their learning experiences."

This response provides examples of how educators go above and beyond to implement the STEAM-IB PYP model for students with learning differences or challenges while exhibiting leadership in how classroom is managed. This is because through differentiated tasks, flexible grouping and varied entry points used by the teachers, all the learning styles and competencies are covered. Almogbel (2015), highlighted that professional learning is essential to provide teachers with required knowledge and skills to put into practice the active STEAM framework. This is underpinned by learning networks where teachers teach and learn in collaborative group work, generate different insights and outcomes, which fosters professional support for a professional learning community for the teachers and in extension the learners.

Another educator discussed involving students in the learning process:

"Sometimes I encourage them to recommend topics that cut across their preferred interests and the topics that are being taught at the classroom. Therefore, not only do they own their learning process, but it also becomes convenient for the integration of STEAM."

By adopting this approach of allowing the students' input increases the students' involvement and individuality in the learning process; the authors also asserting in our related

studies by Rifandi and Rahmi (2019) that student-driven ideas can increase more interest and appreciation regarding STEAM.

A fifth participant emphasised leadership advocacy as a strategy:

"Our principal has been really supportive of STEAM. I have discovered that they have provided more time to do planning and are even asking us to approach the planning in different ways, this has helped a lot."

This response emphasises the importance of institutional support, as leadership that actively promotes STEAM initiatives can help alleviate time constraints and foster a culture of innovation, as suggested by Alqassem et al. (2016).

Finally, another participant mentioned the use of external partnerships:

"We've reached out to local tech companies and universities for guest speakers and materials. These partnerships have really boosted our STEAM program and given students exposure to real-world applications."

Therefore, this strategy of forming the external partnership enables schools to overcome resource constraints and enhance learning experience, strengthen Mansouri and Al-Hamadi's (2018) idea about community and industry support for making STEAM education more effective. In addition, we requested additional participants for a wider better understanding, The Key challenges involve a shortage of resources, teachers' preparedness inconsistency, flexible curriculum design for interdisciplinary learning of STEAM education. Moreover, we asked other participants for more better understanding. The Key challenges include limited resources, varying levels of teacher preparedness, and the need for a flexible curriculum structure that accommodates interdisciplinary learning. Another challenge is also time constrains where the teachers cannot achieve the curriculum delivery while incorporating STEAM activities.

Chapter 5: Discussion

The examination of teachers' perception in this study and the identified themes from the data analysis do provide significant findings in relation to the discussion and offer stronger support to the literature reviewed herein. Implementation of STEAM in IB PYP depends with factors such as curriculum demands, teacher knowledge base, resources, professional development as well as assessment considerations. Altogether, these factors contribute to the experiences and attitude of educators in the process of integrating STEAM, demonstrating the possibilities as well as the problematic aspects of this process. One of the key findings from the data analysis is that teachers appeared to possess basic knowledge about the concept of STEAM education. However, there is a significant amount of doubt as to how the IB PYP curriculum can positively contribute to STEAM integration. The mean score of 2.67 for the statement, "The current IB PYP curriculum allows for the effective integration of STEAM," seems to indicate a dilemma of achievement here where the curriculum in this setting does not appear to effectively facilitate the integration of STEAM classes and concepts. This finding is in consonance with previous findings on STEAM indicating that flexibility and interdisciplinarity have to be provided and upheld as opposed to having rigid subject compartmentalisation (Belbase et al., 2021; Alqassem et al., 2016). One major problem, particularly when dealing with integrated models that combine arts with science, technology, engineering, and mathematics is that structure and organisation inherent to curriculum-based education make it difficult to incorporate the ideas presented by Almogbel (2015). Therefore, the data establishes the basic significance of historical and contextualised curriculum that meets the integrated STEAM education platform.

Furthermore, the assessment of creativity and outcomes of an interdisciplinary setting became an issue to consider. The mean score of 3.25 for the concern 'Teachers are still struggling to assess STEAM activities properly' coincides with the literature that has espoused the challenges of evaluating creative and critical thinking skills that are encouraged through STEAM (Gryson et al., 2024). To address the assessment issues, there is a need for new forms of assessment that support the goals of STEAM due to the fact that conventional methods normally reward rote learning but not ability to think analytically or creatively (Ritz & Fan, 2015). According to literature, if one has to embrace the true spirit of STEAM education, the teachers are encouraged to design the assessments in a way that emphasize the process of learning as much as the outcome

(Colucci-Gray et al., 2019). Teacher preparation is another pertinent issue highlighted by the findings. However, inverse relationship was established between preparations level of teachers and perceived effectiveness of curriculum, indicating that the more teachers are prepared to teach STEAM the higher their expectations of the curriculum in terms of supporting those practices. This correlation is supplemented by Al Mulhim (2014), who indicated that experienced educators require more from curricular reforms. Further, as teachers get more experience in teaching STEAM content, they may be more dissatisfied with the existing frameworks that do not encourage creativity. This highlights a paradox in teacher education in terms of self-organising work, increased competence may result in closer examination of the systems put in place for proactively delivering teaching and learning.

The requirement for professional development was seen as a theme throughout the analysis of the data; the statement received a mean score of 3.14 The finding is consistent with the previous studies and literature; future and targeted professional development for meeting the needs of STEAM education are essential (Ammar, Al-Thani & Ahmad, 2024; PricewaterhouseCoopers, 2016). They also listed specific training and development needs that transcend routine teaching and learning to encompass interdisciplinary and creative teaching practice. The current professional development interventions available do not sufficiently address teachers' needs as these, in most cases, are not grounded in a STEAM perspective (Alswilem, 2019). This suggests the need for educational leaders to both develop and provide PD that is timely, meaningful and long-term to cultivate the culture of innovation. Technological resources came out as another theme with the teachers expressing that they have limited access to technologies needed for teaching the router and other STEAM activities in varying degrees. The mean score of 3.00 for the statement. The research emphasising that access to technology is crucial for the hands-on, experiential learning experiences characteristic of effective STEAM education (Nguyen, Nguyen, & Tran, 2020). Even if teachers are well-prepared and willing to integrate STEAM activities into their lesson plans, they may encounter numerous challenges due to a lack of resources and support. This issue brings out the need for fair distribution of resources in schools so that all students are provided with the essential tools for effective innovative learning.

Interactions between the teachers were also mentioned as one of the key working approaches to the implementation of STEAM activities. The mean score of 3.37 obtained on the

statement shows that teachers do appreciate the idea of collaborative efforts but by analysing the correlation values and coefficients of determination it has become clear that collaboration does not predict perceptions of the teachers on the issue of effectiveness of the curriculum. This contradiction could be the result of actual collaborative practices where teachers are concerned: while there are collective processes involved, institutions might restrain the scope and effectiveness of these joint actions (Herro et al., 2018). According to the literature, collaboration also needs time and institutional support to encourage planning in an interdisciplinary manner (Bahn, 2022). Therefore, it becomes crucial to remove all structural impediments to practice collaboration so as to derive optimal benefits from teacher teamwork. The findings of the data analysis and the subsequent employment of codebook themes offer a complex understanding of the application of aspects of STEAM education within the context of the IB PYP.

The study identifies several issues and concerns in curriculum development, assessment, teacher training, resource adoption, and partnership. These concerns reflect the general discussion in the literature regarding flexibility concerning the curricular frameworks and the necessity for developing new forms of assessments. The above-discussed challenges require attention from stakeholders with regards to changes in curriculum, Professional Learning Communities, equitable distribution of resources, and collaboration. They are crucial mainly for the purpose of enhancing teachers' perceptions regarding integration of STEAM into K-12 education and providing the students with concepts and abilities relating to creative as well as critical thinking in the framework of the 21st century environment.

Chapter 6: Conclusion and Recommendations

6.1 Introduction to Chapter

This chapter gives the final results of the research regarding the implementation of STEAM within the context of the IB PYP in Riyadh schools. The last chapter discusses the result, suggests measures that may promote the improvement of the integration process, explains the applicational value of the study, outlines the limitation of the study, and provides conclusion on the assertiveness of the research to the theory and practice of the academic and education discipline.

6.2 Summary of the Study's Outcomes

The study also established a positive theoretical fit between the interdisciplinary, integrated inquiry approaches of STEAM and the IB PYP. They both engage many disciplines and promote creativity through students investigating on their own. Teachers greatly appreciated this integration, as both STEAM and IB PYP focus on integrating knowledge by encouraging students to explore connections with other subjects. However, implementing this alignment in the classroom proved to be challenging. The integration of STEAM's innovative and cross-content projects with the IB PYP's assigned scope and sequence, as well as the assessment strategies, presented challenges. Most IB PYP assessment criteria are rigid, traditional, and content-based; it is challenging to explain the dynamic and innovative artifacts created through STEAM learning.

The shift from a disciplinary basis for integrating theory into practice necessitated a comprehensive overhaul of the teaching methods across the two frameworks. Teachers' surveys and interviews exposed that they saw STEAM as a rich addition to the current IB PYP curriculum, certain barriers hindered the practice of the cross-curricular approach that STEAM entails. In practical terms, this entailed reflection on how one structured a unit, how interdisciplinary colleagues approached the material, and how one measured student learning outcomes. Although these challenges are evident, the theoretical integration of STEAM and IB PYP suggests a promising framework for additional instantiation and COCA synthesis in classrooms.

The following challenges were identified in relation to the implementation of STEAM in the context of the IB PYP in Riyadh schools. Inadequate resources, including robots, coding platforms, and art-related equipment, were among the most mentioned needs. Educators were
unable to provide enigmatic and captivating STEAM lessons due to this shortage, despite their

creative use of the framework. Lack of funds made it challenging to incorporate technology and arts into STEM subjects, thereby influencing the quality and potential outcomes of STEAM projects for the children.
Moreover, the following areas of need were identified: Lack of effective professional development is another challenge due to the few studies done with a view of enhancing the same. The survey findings suggest that teachers have not been provided with the professional learning they require to integrate STEAM in their classroom practice a finding that resonates with existing STEAM research. Academics said they lacked adequate preparation for interdisciplinarity more so when it came to arts and technology in STEM areas. Lack of professional practice reviews frequently keeps teachers in the undecided state on what kind of interdisciplinary projectis and how creativity of STEAM projects is evaluated. The analysis also unveiled that the organisation and culture of the school played a big role in the effectiveness of the developed STEAM. These barriers included low morale because some administrators and staff were resisting change and wanted to maintain the traditional approach to teaching. Other barriers included time constraints, as teachers struggled to allocate enough time to implement interdisciplinary STEAM lessons within the limited time available. Another challenge was the use of enclave learning approaches common in traditional curriculum and assessment systems. These frameworks do not address the creative and problem-solving nature of STEAM and fail to help educators assess the student's learning process and progress.
However, this study established that there were challenges in the integration of STEAM in the schools under the implementation of the IB PYP program, but this caused a positive impact on the students' engagement. That's why teachers found that students' interest in learning increased when they participated in STEAM projects. The exploratory characteristics of STEAM enhance the engagement of the lesson by empowering students to drive their own learning process, thereby motivating them. Using both creativity and science, students were able to develop solutions to a number of problems that are typically limited in traditional classroom environments. This approach facilitated the development of problem-solving skills, which are crucial in addressing the challenges of the current century.

As the students' participation grows, the teachers struggle to measure the creativity and achievement of interdisciplinary learning within the context or framework of IB PYP. The current assessment systems do not cater to the type of learning that STEAM demands. Some of the things

teachers communicated included the challenge of getting students assessed, particularly by using standard assessments that barely captured the creativity of the students in subject matters where they applied inter-disciplinary approaches in project development. The IB PYP's assessment form does not align with the STSEAM skills and competencies identified in the STEAM learning outcomes, necessitating the development of new evaluation tools and techniques to match the STEAM learning outcomes.

The study presented several approaches in response to these challenges as part of the improvement process of STEAM integration, focusing on both teacher education and resource availability. Lack of regular professional development was one of the principles to be enhanced; you might say it was emphasised. To support the integration of STEAM into classroom practice, teachers recommended that there be ongoing, targeted professional development. Such training should cover areas such as shared interdisciplinary lesson plans, the integration of technology in the teaching and learning process, and infusing art into STEM disciplines. Further, the study also focused on the issues related to the planning of the teachers in a group or in group manner. Expanding collaboration between generalist and specialist teachers ensures that STEAM units are coherent and integrated with the IB PYP inquiry approach to learning and STEAM's integrated creativity.

The study also Generalisations about technology investment and resource allocation were also underscored in the study. Teachers require schools to procure the basic materials required for the delivery of STEAM activities, including robot sets, coding interfaces, and art equipment. Lacking such resources, it is impossible to teach the kind of practical, imaginative problems characteristic of STEAM initiatives. The headteacher should provide the teachers with updated technology and adequate teaching and learning resources, as this will facilitate the improvement of the quality and interest of the students. Additionally, school leaders are expected to develop institutional support for STEAM interventions as a prerequisite to becoming practice leaders. This paper suggests that administrators should strive to foster innovation through cross-teaching practices that facilitate cross-subject collaboration and time provision, thereby enabling the

integration of new teaching practices. Despite the difficulties experienced in putting the above into practice, specifically in relation to resources, teacher training, and assessment, the study reveals the following recommendation for Riyadh schools to be able to implement STEAM. By addressing these challenges, educators can achieve the full benefits of implementing STEAM curriculum and improve the interest, innovation, and achievement of the students within the context of the IB PYP framework.

6.3 Recommendations

The following recommendations can be made to improve the implementation of STEAM education in the International Baccalaureate Primary Years Programme (IB PYP) based on the findings of this study. First, professional development needs to be addressed for teachers. In- service training that is centered on STEAM methodologies and IBL will help prepare teachers with proper skills to adapt such strategies into the classroom (Aldossari, 2018). It is also important to have workshops and collaborative sessions where educators can exchange ideas and examples of successful teaching practices, thereby creating a community of practice for innovative teaching methods.

Second, schools should create opportunities for teachers to collaborate across subject areas. Through the elimination of compartmentalisation, educators can design integrated learning experiences that better mimic real-life scenarios. For example, cooperation in lesson planning between the art and science teachers may result in students being asked to undertake activities that involve the use of knowledge from both subjects (Quigley et al., 2017). This pedagogical approach not only enhances the comprehension of learners but also imitates the system of knowledge in the contemporary world.

Moreover, the integration of technology into STEAM education is crucial in the current society. As noted by Almogbel (2015), technology can improve the learning process since it allows one to access various sources and participate in group assignments. Therefore, schools should consider allocating resources to buy digital tools and platforms that fostered more interactive learning, where students can actively solve problems or think critically. An evaluating student learning should ideally be in line with the goals of STEAM and IB PYP. These learning experiences are unlikely to be assessed by conventional means like exams, which make it difficult to measure the impact of the programs in terms of creativity and teamwork. Therefore, using formative

assessment and project-based evaluation is more effective in monitoring the achievement of students (Ammar et al., 2024). Therefore, educational institutions will be able to develop a positive learning culture that encourages creativity, problem solving, and learning throughout the life span. To ensure that greater forcus is placed on the application of the science content areas across the IB PYP transdisciplinary themes, specific professional development in necessary. Teachers also need to be trained on how to align expectations for performance with the inquiry-based learning approaches promoted in the IB PYP (Wootten, 20219). This can be done through workshops and brainstorming sessions in which educators collectively create integrated curriculum subtopics (Green, 2017).

Furthermore, there is the recommendation that Curriculum Mapping should be done in an attempt to incorporate the 3D learning framework within the context of IB PYP's thematic studies (Friend, 2020). The interdisciplinary collaborative planning teams including teachers from various subject areas will design the subject-integrated units in relation to scientific and inquiry practices alongside maintaining the IB PYP focus (Dix & Sniedze, 2020). These strategies assist in preventing what is known in the literature as 'theoretical proliferation' without corresponding practical, meaningful learning experiences.

6.4 Practical Implications of the Study

This study has several theoretical implications that may help educators and educational institutions that have embraced the STEAM education within the context of the IB PYP. Firstly, the schools should bring focus on STEAM approaches since it helps in the development of successful educations which in turn help learners in developing critical, creative and co-operative abilities. This integration enables the acquisition of a systemic view of subjects and to prepare for the complexity of the world (Al Mulhim, 2014).

Moreover, the study also highlights the need of perfecting the professional experience of the teachers. Therefore, it becomes crucial to have educators that are trained to teach STEAM concepts to students improve the quality of education. They also offered suggestions for shared planning and integration of instruction and learning across the content areas to create greater learning experiences for students.

In addition, it highlights the importance of the use of technology-based teaching instruments in learning contexts. Therefore, schools should possibly make investments in these digital tools that enrich students' active and engaging learning experiences. Therefore, the results of the present research indicate the need for a comprehensive implementation of the educational change based on the ternary relations of subject disciplines and addressing the necessity of the development of new models of teaching practices for the preparation of young people for the future.

6.5 Limitations of the Study

The current research provides important insights about the incorporation of STEAM education in relation to the IB PYP. The research was carried out only in a given geographical region, and so the findings might not be generalisable to other regions or the system of education in other countries. The application of STEAM approaches requires one to understand cultural and educational disparities within the different regions. Furthermore, the choice of interviews as data collection instruments in the study may threaten validity because the participants' responses may be skewed by their personal views or past experience. Although, qualitative data provides richness, it does not have the quantitative credibility that could have been useful in confirming the research outcomes. However, the sample size used in this study was adequate for the qualitative study, but it may not be representative of diverse perspectives in various educational settings and teaching practices. The use of a small sample size means that issues that may be general to STEAM education may not be captured. The future studies should include a larger and more diverse population, and the study should also incorporate quantitative design to gain a better insight into the efficacy of STEAM education across various educational setting.

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Appendix

Survey form

Evaluating STEAM Integration into IB PYP in Riyadh Schools: Teacher Perspectives Section 1: Demographic Information

Gender

- Male
- Female

Age Group

- 20–29 years
- 30–39 years
- 40–49 years
- 50 years and above

Years of Teaching Experience

- Less than 1 year
- 1–3 years
- 4–7 years
- 8–15 years
- 16+ years

Teaching Grade Level

- Pre-Primary (KG)
- Primary (Grades 1–3)
- Primary (Grades 4–6)

Section 2: Perceptions of STEAM Integration

I am familiar with the concept of STEAM education.

- Strongly Agree Agree
- Neutral Disagree
- Strongly Disagree

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I believe that integrating Arts into STEM (STEAM) is essential for holistic student development.

- Strongly Agree
- Agree
- Neutral
- Disagree

- Strongly Disagree

The current IB PYP curriculum allows for the effective integration of STEAM.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Section 3: Curriculum and Assessment

It is challenging to assess creativity and interdisciplinary learning outcomes in STEAM within the IB PYP framework.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

The main challenge in integrating STEAM with IB PYP assessments is the lack of standardized tools.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Section 4: Teacher Preparedness and Professional Development

I feel adequately prepared to teach STEAM subjects in my classroom.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

I believe that ongoing professional development is crucial for effective STEAM integration.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Section 5: Technological Resources

My school provides sufficient technological resources (e.g., robotics, coding platforms) for STEAM activities.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Section 6: Collaboration and Support

I regularly collaborate with other teachers to create interdisciplinary STEAM lessons.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Section 7: Open-Ended

What additional support would help you improve STEAM integration in your school?

(Open-ended Responses)